Memoirs of the Queensland Museum.

VOL. XII. PART II.
ISSUED 6th NOVEMBER, 1943.

EDITED BY THE DIRECTOR, H. A. LONGMAN.

ISSUED BY THE AUTHORITY OF THE CHIEF SECRETARY FOR QUEENSLAND,
THE HON. F. A. COOPER.

REVISION OF AUSTRALIAN SPECIES OF SCOMBEROMORUS.

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Plates VI–VIII.

Introduction.—The Spanish Mackerel comprise an important group of deep-sea food fishes which support a valuable coastal pelagic fishery in Australian waters, particularly Queensland, northern New South Wales and Western Australia. The industry is based primarily on one particular specie, namely the Barred Spanish Mackerel, *Scomberomorus* (*Cybium*) *commerson* caught by trolling in coastal waters. Another migratory species, *Scomberomorus* (*Cybium*) *queenslandicus* sp. nov., enters the estuaries along the coast during the winter months and in season supports a small net fishery. There are in addition several other marketable Spanish Mackerels, which, being caught in smaller numbers, are rather too rare to be of economic importance. All the Australian species, like their relatives from overseas, are recognised as first class food-fishes and, in addition, the larger forms provide abundant sport for Game anglers along the coast of New South Wales and the Great Barrier Reef.

Since there appears to be a decline in the annual catches of these fishes per unit of fishing effort despite improvements in technique and equipment, and because there has been an enormous increase in fishing activities during the spawning season, investigations concerning their biology and economics have been instigated in order that sound scientific conservational measures might be derived. It is hardly necessary to emphasise the economic consequences resultant from over-exploitation of the fishery and the effect of decreased output upon the livelihoods of all whom the industry concerns.

The first problem in this study concerns the exact diagnosis and subsequent identification of all species. Until a clear conception of the species which comprise the schools inhabiting our waters has been formulated it is impossible to expect any progress in the understanding of their Biology. As could be expected, the handling of many thousand specimens in the field and careful laboratory examination have revealed the need for revising existent conceptions of the identity of Australian forms.

Summary.—Various aspects of the taxonomy of the genus *Scomberomorus* Lacépède are here discussed. Nine subgenera are recognised and two of these (*Indocybium* and *Pseudosawara*) are described as new. Subgeneric characters and phylogeny are discussed.

Four valid species of Spanish Mackerels are shown to occur in Australian seas. These are illustrated and fully described from series of specimens. Distribution, nomenclature and morphological features are discussed in detail for each species.

Formerly three Australian species had been recognised, namely *S. commerson*, *S. guttatus* and *S. semifasciatus*. It is here shown that the spotted form *S. guttatus* (Bl. & Schn.) does not occur in Australian waters. In addition *S. niphonius* (Cuv.

& Val.), a Japanese form, has been added to Australian lists as a new record and a common commercial species is recognised as new and here described under the name *Scomberomorus* (*Cybium*) *queenslandicus*.

REVIEW AND ANALYSIS OF THE GENUS SCOMBEROMORUS LACÉPÈDE.

(A) DISTRIBUTION.—The fishes of the Scomberomoridae are without exception coastal inhabitants. Throughout the world they are seldom found in water deeper than forty fathoms. Some species frequent estuarine waters at certain seasons of the year, some prefer discoloured waters but the majority of species inhabit the clear tropical waters of ocean currents around rocky islets and coral reefs, tide rips and off-shore currents. Their preference for waters of low density and medium salinity apparently accounts for their coastal distributions. All known species, about twenty in number, are of tropical or subtropical coastal distribution. Apparently temperature is a governing factor in geographical distribution, as the range of all known species falls within the boundaries set by the 68° F. summer ocean isotherms of both hemispheres. In this respect they are seen to resemble the allied genus *Acanthocybium* but differ from *Grammatorcynus* whose limits are the 77° F. summer ocean isotherms. In most cases annual spawning migrations are made to keep within these temperature limitations.

(B) NOMENCLATURE—*Cybium* or *Scomberomorus* ?—During the past sixty years there has been much controversial opinion amongst systematic ichthyologists regarding the use of the names *Scomberomorus* Lacépède and *Cybium* Cuvier. Prior to the resurrection of the former name by Jordan and Gilbert (Proc. U.S. Nat. Mus., V, 1883, p. 573), *Cybium* had been applied almost universally and without question by all European authorities following its adoption first by Cuvier in 1829 (Regne Anim. ed. 2, II, p. 199). Although there is a modern tendency to associate these names with separate subgenera, it must be admitted that the original conception of the two names was one of synonymy. *Scomberomorus* Lac. has chronological priority over *Cybium* Cuvier, and should be adopted on these grounds. There is no reason why its validity should be doubted on the grounds given by Kishinouye (1923, Journ. Coll. Agric., Univ. Tokyo, VIII, p. 416), namely that Lacépède's description of the genotype *Scomberomorus plumierii* from Martinique (Hist. Nat. Poiss., III, 1802, p. 292) being drawn up from Aubriet's inferior copy of Plumier's painting was diffuse and inaccurate. It is true that Lacépède (*loc. cit.*, IV, p. 711 ; V, p. 789) tried to withdraw his genus upon recognition of the synonymy of this species with *Scomber regalis* Bloch from Antilles (Nat. ausl. Fische, VII, 1793, p. 38, pl. 333) but he did appreciate generic differences between this fish and the genus *Scomber* Linnaeus. If one generic name is to be adopted to denote this group, then the older name *Scomberomorus* Lac. must take precedence.

An exhaustive study of the literature pertaining to this particular group of fishes—some 400 references in all—reveals that this *Scomberomorus* of Lacépède can be subdivided conveniently into nine subgenera. Generally speaking the name *Scomberomorus* Lac. designates that group of Scombroid fishes with a more or less laterally-compressed elongate body covered with minute scales not differentiated to form a corselet in the pectoral region. A single lateral line distinguishes it from *Grammatorcynus* Gill and the possession of a few gill-rakers separates it from *Acanthocybium* Gill. Most other characters are variable, especially vertebral and gill-raker counts. Likewise the swim-bladder is of doubtful constancy and apparently

may vary within the geographical races of the same species, *e.g. Cybium commerson* where it occurs in the Japanese race but is absent in Australian specimens.

(C) SUB-GENERA—CHARACTERS AND SPECIES ALLOCATION :

(i) *SCOMBEROMORUS* Jordan & Hubbs, 1925.

Jordan & Hubbs, Mem. Carneg. Mus., X, 2, 1925, p. 212.
Deraniyagala, Ceylon J. Sci. (B), XVIII, p. 38, 1933 (in part).

Air-bladder present ; lateral line simple ; 17-18 spines in first dorsal fin ; 11-14 gill-rakers on lower branch of first gill-arch ; teeth straight and laterally compressed, non-serrulate.

S. regalis (Bloch), *S. maculatus* (Mitchill) and *S. sierra* Jord. & Starks from North America and *S. tritor* (Cuv. & Val.) from N.W. Africa. Not Australian. Modern authorities claim the synonymy of *S. maculatus* (N. America, Atlantic) = *S. sierra* (N. America, Pacific) = *S. tritor* (N. W. Africa, Atlantic). These are probably geographical races of the same species. In this connection can be noted that the suggested synonymy of Bennett's genotype *Apolectus immunis* from N. W. Africa should not be with American *S. maculatus* but more strictly = *S. tritor* from same type locality. If Bennett's teeth characters can be considered as erroneous and the above synonymy adopted, then subgenus *Scomberomorus* J. & H. is synonymous with *Apodontis* Benn. (= *Apolectus* Benn., preocc.—1831, Proc. Comm. Zool. Soc., I, p. 169 and p. 146).

Genotype = *Scomber regalis* Bloch (Antilles) (= *Scomberomorus plumierii* Lacépède (Martinique).)

(ii) *CYBIUM* Jordan & Hubbs, 1925.

Jordan & Hubbs, Mem. Carneg. Mus., X, 2, 1925, p. 212.
Fowler, Hong Kong Nat., VII, 1936, p. 70 (in part).

Cibium of Troschel (Arch. f. Naturg., Weigman, XV, 1, 1849, p. 380) though probably intended to carry the same significance as *Cybium* Cuvier (Regne Anim., ed. 2, II, 1829, p. 199) was never the less designated with having three gill-rakers. Mention of this character specifically conveys essentially the same restricted meaning as subgenus *Cybium* J. & H.

Gill-rakers very short and few in number ; teeth laterally compressed, with minutely serrulate edges ; swim bladder present or absent as stated above ; lateral-line simple with vestigial ramification in older age groups ; 16 spines in first dorsal fin.

S. commerson (Lacep.) from Indo-Pacific (Africa, Red Sea, India, Malaya, China, Japan, Indian Archipelago and Australia) and *S. queenslandicus* sp. nov. from N.E. and N.W. Australia. Note—no other Australian forms are referable to subgenus *Cybium* though listed by Whitley (Mem. Qld. Mus., XI, 1936, p. 32), morphological differences being more significant than geographical distribution.

Genotype = *Scomber commerson* Lacep. (= *Cybium commersonii* Cuv. (Mauritius)). (Also = genotype of *Cybium* Cuv. by designation, Gill, 1863, Proc. Acad. Nat. Sc. Phila., p. 126).

(iii) *SAWARA* Jordan & Hubbs, 1925.

Jordan & Hubbs, Mem. Carneg. Mus., X, 2, 1925, p. 214.
? Deraniyagala, Ceylon J. Sci. (B), XVIII, 1933, p. 38.
Fowler, Hong Kong Nat., VII, 1936, p. 70 (in part).

Sawara was originally erected for reception of *Cybium niphonium* C. & V., which was stated by Kishinouye (Journ. Coll. Agric. Univ. Tokyo, VIII, 1923, p.

421) to be specially characterised by a branched lateral line and the absence of a swim bladder. There are said to be short sharp branch canals on either side of the lateral line. They are apparently true ramifications as are seen well developed in *Acanthocybium* or vestigially in older age groups of *S. commersion, i.e.*, morphologically different from the "branching" in *Pseudosawarra*. It is doubtful whether the branches are as distinct as depicted by Kikkawa (Kishinouye, *loc. cit.*, p. xx, f. 32) or as copied by Fowler (Hong Kong Nat., VII, 1936, f. 7). I am not willing to accept that Australian specimens (age groups normally caught) possess a branched lateral line, but admittedly there is a wide band of enlarged scales fringing both sides of the lateral line and superficially these give an appearance of vestigial ramification of the main canal. In this connection it is of interest to note that Tanaka (Fishes Japan, IX, 1912, p. 154) does not remark on lateral-line ramification and Tortonese (Boll. Mus. Zool. Anat. Comp. Torino, XLVII, 1939, p. 321) revived Günther's name *gracilis* for application to an immature oriental specimen with simple lateral line. Ramification of the lateral line in the genotype is therefore questionable and is probably, if existent, an age effect as in *S. commerson*. The abnormally large number of dorsal spines (20–22) becomes the principal subgeneric character of *Sawara*.

S. niphonius (C. & V.) is sole representative, from Japan and East coast of Australia. It is fairly certain that *C. gracile* Günth. and *S. gracilis* Tort. are synonyms of this species.

(iv) *PSEUDOSAWARA* Subgenus Nov.

A new subgenus is necessary for reception of two species possessing another type of lateral-line branching. This is not true ramification but a branching effect produced by the continuation backwards of the area of minutely furrowed skin caused by presence of tracts of cutaneous mucous canals. Such areas are seen on the postero-dorsal region of the head of all species of *Scomberomorus*. In the subgenus *Pseudosawara* such canals are bunched together along both sides of the lateral line as well as on the head. They all point outwards and backwards and are densest towards the anterior part of the lateral line. Gill-rakers 11-13; Dorsal spines 14-16.

S. kuhlii (C. & V.) (= *C. guttatum* of Kishinouye, Journ. Coll. Agric. Univ. Tokyo, VIII, 1923 and Deraniyagala, Ceylon J. Sci. (B), XVIII, 1933 = *S. kuhlii* Day, Fish. India, 1876, p. 254, pl. lvi, f. 2) from India, Indian Archipelago and Japan. Also *S. koreanus* Kish. from Korea only. No Australian species.

Genotype—*Cybium kuhlii* Cuv. & Val. (Hist. Nat. Poiss., VIII, 1831, p. 178) from Java.

(v) *INDOCYBIUM* Subgenus Nov.

Indocybium is proposed as a new subgenus to receive at least three Indo-Pacific species which can be readily distinguished by virtue of distinctive body proportions. Compared with other subgenera the head is smaller, the flukes of the caudal fin larger. The distance between tips of anal and soft dorsal fins large. Lateral line simple; swim-bladder absent; gill-rakers = 2 + 8 or 11; 13-17 dorsal spines; teeth compressed, non-serrulate and slightly curved inward.

S. semifasciatus (Macleay) (= *C. tigris* De Vis) from Queensland; *S. lineolatus* (Cuvier) (= *C. interruptum* C. & V.) from India, Indian Archipelago and Africa; *S. guttatus* (Bloch & Schneider) India and Indian Archipelago.

Genotype = *Cybium semifasciatum* Macleay, Proc. Linn. Soc. N.S.W., VIII, 1883, p. 205 (Burdekin R., Qld.).

(vi) *SIERRA* Fowler, 1905.

Fowler, Proc. Acad. Nat. Sci. Phila., LVI, 1905, p. 766.

Large forms with greatly flexed unbranched lateral line ; gill-rakers 1 or 2 + 8 or 9 ; dorsal spines 14-16 ; teeth straight and compressed.

S. cavalla (Cuv.) from Atlantic coast N. America and Brazil ; *S. sinensis* (Lacép.) (= *C. cambodgiense* Durand, Instit. Oceanogr. l'Indochine, XXXVI, 1940, p. 37, pl. vi—immature) from N. China & Japan may belong to this subgenus. Not Australian.

Genotype = *Cybium cavalla* Cuvier, Regne Anim., ed. 2, II, 1829, p. 200 (after Marcgrave, from Brazil).

(vii) *CHRIOMITRA* Lockington, 1880.

Lockington, Proc. Acad. Nat. Sc. Phila, 1879, p. 133.

Chriomitra is represented by a single species of rare occurrence and limited in distribution to part of Californian coast. Lateral line apparently simple ; gill-rakers abnormally numerous *viz.* 18. The two dorsal fins are separated by a gap as in *Cybiosarda* and *Sarda*. This fish has never been illustrated. It is apparently a true Scomberomorid.

Genotype = *Chriomitra concolor*, Lockington, Proc. Acad. Nat. Sc. Phila., 1879, p. 133 (Monterey Bay, Calif.). This is only known species. Not Australian.

(viii) *CYBIOSARDA* Whitley, 1935.

Whitley, Rec. Aust. Mus., XIX, 4, 1935, p. 236.
Whitley, Mem. Qld. Mus., XI, i, 1936, p. 42.

Cybiosarda Whitley may not be strictly Scomberomorid—lying on border line between *Sarda* and *Scomberomorus*. It is probably closest to *Sarda* which it resembles in external features and skeletal characters. That the first spine of spinous dorsal fin is longer than second spine rather excludes it from being truly Scomberomorid. The form of the teeth (sub-conical and curved) as well as their arrangement are typically *Sarda*. *Chriomitra* is apparently a phylogenetic link between *Cybiosarda* and more typical Scomberomorids.

Cybiosarda elegans from E. & W. coasts of Australia is only species.

Genotype = *Scomberomorus* (*Cybiosarda*) *elegans* Whitley, Rec. Aust. Mus., XIX, 4, 1935, p. 236 (Moreton Bay, Qld.).

(ix) *LEPIDOCYBIUM* Gill, 1863.

Gill, Proc. Acad. Nat. Sci. Phila., 1863, p. 125.

Gill erected this genus for *Cybium flavo-brunneum* Smith. It differs significantly from all other Scomberomorids by fact that teeth are conical and recurved—those of upper jaw series being larger than those in the lower jaw. The first dorsal fin has

12 low spines and anal and dorsal finlets are reduced to 4 or 5. Not strictly Scomberomorid and phylogenetically constitutes a possible link between more typical Scomberomorids and *Thyrsites* or *Ruvettus* of the Gempylidae, especially in relation to the dentition and reduction of finlets.

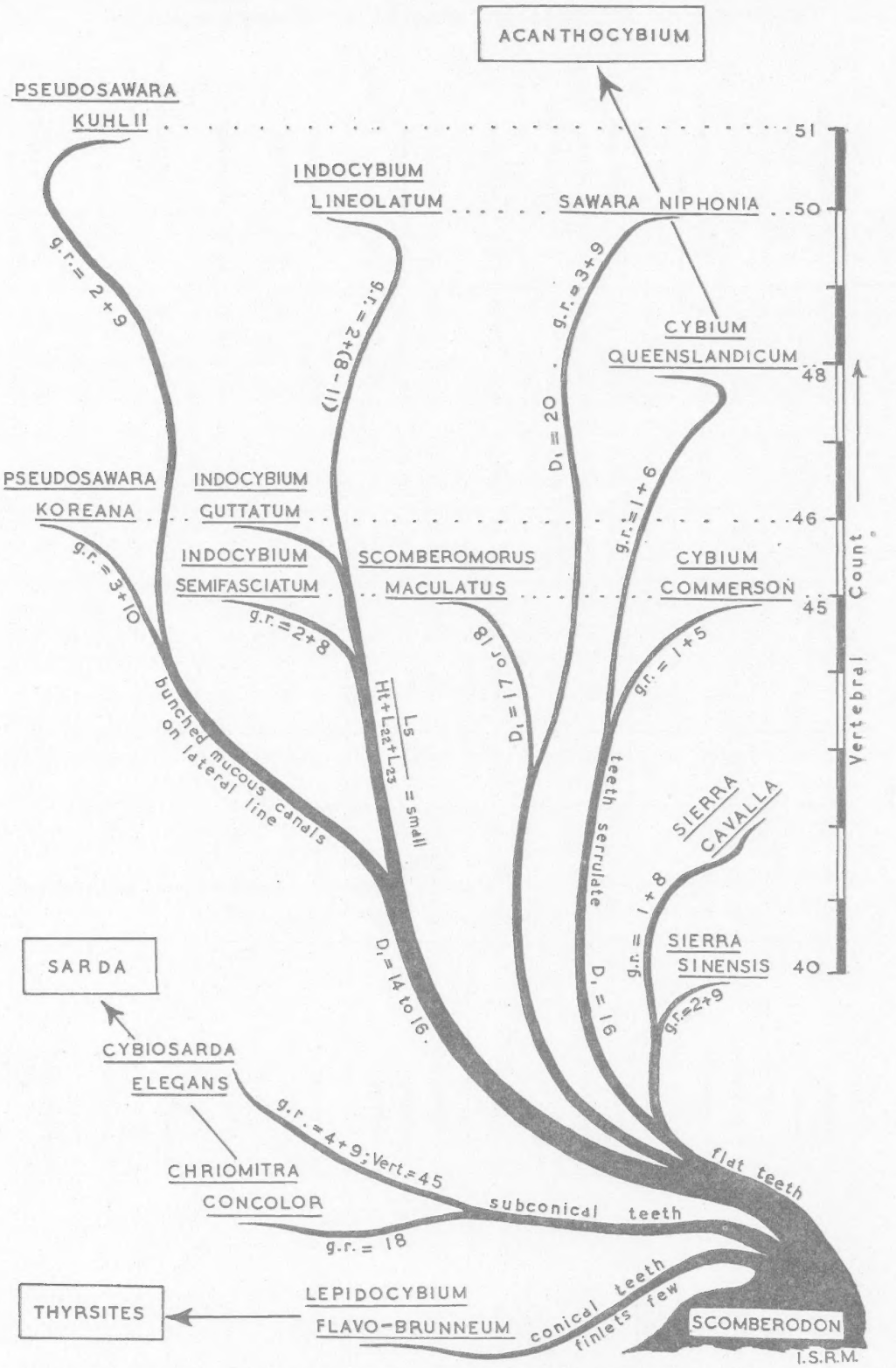
There is only one species—*L. flavobrunneum*. It is rare but widely distributed. Its greatest interest lies in the fact that a survey of the relevant literature has brought forth some new points in synonymy of this species. Only one South African specimen (the genotype) is known and upon this is based the records of Smith 1849 (Cape of Good Hope), Günther 1860, Bleeker 1860, Gill 1863, Gilchrist 1902, Thompson, 1918 and Barnard 1927. Weber (Abhandl. Senck. Naturf. Ges., XXXIV, 1911, p. 31) records it from Aru Is. (Barkai). It has been redescribed under three different names but nobody seems to have associated these with the earliest combination, *i.e. Lepidocybium flavo-brunneum* (Smith). The synonyms over which this combination takes priority are—*Xenogramma carinatum* Waite (Rec. Aust. Mus., V, 1904, p. 158, pl. xix, f. 1, Lord Howe Is.), *Diplogonurus maderensis* Noronha (Ann. Carneg. Mus., XVI, 3-4, 1926, p. 381, f. 1 ; also Fowler, Bull. Amer. Mus. Nat. Hist., LXX, 2, 1936, p. 627, 1275, f. 545, Madiera) and *Lepidosarda retigramma* Kishinouye (Journ. Coll. Agric. Univ. Tokyo, VII, 4, 1926, p. 377, f. 1—Japan). Careful perusal of descriptions and comparison of figures will confirm this view.

(D) Phylogenetic Interpretation of Genera and Species.—To assist in the diagnosis of Australian forms Table I. is provided, setting out salient characters of each valid species and Text-fig. I. giving an indication of origin and interrelations of species concerned.

The nine subgenera represent trends in different directions diverging from some common ancestral stock or archaic form or forms constituting the now extinct analogous genus *Scomberodon* van Beneden (Bull. Acad. Roy. Belg. (2), XXXI, 1871, p. 504), evidence of the existence of which comes from Miocene, Oligocene and Eocene clays of Europe, N. America and the Indian Archipelago. It is of interest to note that species were on the average larger in size than modern representatives of the genus and the vertebral number was smaller (*e.g.* 15 + 15 = 30 in *Cybium speciosum* Ag.) (*vide* Woodward, B. M. Cat. Foss. Fish., IV, 1901, p. 465 ; Dollo & Storms, Zool. Anzeiger, XI, 1888, p. 265). The teeth of fossil forms are described as conical or flattened, usually broad and invariably laterally compressed. In dentition at least most Scomberomorids have diverged little from their ancestral stock but there is a definite tendency towards increase in the vertebral count. Variation in vertebral count makes it impossible to use this character for a primary subdivision of the genus. Variation in vertebral count in each subgenus can be considered in the light of a phylogenetic progression along each branch. In respect to manifestation of high vertebral count, *Pseudosawara kuhlii* (51), *Indocybium lineolatum* (50), *Sawara niphonia* (50) and *Cybium queenslandicus* (48) show a convergence towards *Acanthocybium* which has 54-64 vertebrae. *S. niphonia* shows further convergence in this direction in respect to the long dorsal fin (20-22 spines, cf. Wahoo 25-26 spines). Subgenus *Cybium* shows similar approach from another angle, namely by reduction in size and number of gill-rakers, branching of lateral line and development of perfectly flat teeth with minutely serrulate edges.

TABLE I—CHARACTERS OF THE GENUS *Scomberomorus* Lacépède. (Maximum known range of variation given in each case.)

Subgenus.	Species.	Vertebrae.	Gill-rakers.		Pectoral Fin.	Dorsal Fins.			Anal Fins.		Adult Markings.
			Upper.	Lower.		D_1	D_2	Finlets.	A.	Finlets.	
Sierra Fowler	*S. sinensis*	18 + 22 = 40	2	9	18–22	16	15–16	7–8	15–19	6–7	Large blotches
	S. cavalla	..	1–2	6–8	22	14–16	15–17	8–9	16–17	8–10	Immaculate
Cybium Jord. & Hubbs	*S. commerson*	20 + 25 = 45	0–2	3–6	21–24	14–17	16–19	8–10	14–18	8–10	Vertical bars
	S. queenslandicus	20 + 28 = 48	0–1	4–7	20–23	15–17	16–20	9–10	15–20	9–10	Large blotches
Scomberomorus Jord. & Hubbs ..	*S. maculatus*	45	2–3	10–13	18–22	17–18	15–18	7–9	17–19	8–9	Small spots
	S. sierra	..	3–4	11–13	..	17–18	15–16	8–9	17	8–9	Small spots
	S. tritor	..	4	12	20–22	17	16–17	8–10	16–18	8–10	Blotches
	S. regalis	..	2–3	11–12	..	17–18	15–17	8–10	16–19	8–10	Elongate spots
Sawara Jord. & Hubbs	*S. niphonius*	22 + 28 = 50	2–3	9–11	21–23	20–22	16–19	8–10	15–18	8–9	Small spots
Indocybium Subgen. nov.	*S. semifasciatus*	19 + 26 = 45	2–3	7–8	22–23	13–15	17–20	8–10	20–22	8–10	Vertical bars
	S. guttatus	20 + 26 = 46	2	9	21	15–17	18–20	8–9	19–21	8–10	Small spots
	S. lineolatus	21 + 29 = 50	2–3	8–11	21–23	15–17	18–20	9–10	18–21	9–10	Horizontal streaks
Pseudosawara Subgen. nov.	*S. koreanus*	20 + 26 = 46	3	10	..	14	19–21	9	18–21	7	Small spots
	S. kuhlii	21 + 30 = 51	2–3	8–9	20–23	15–16	18–20	8–9	19–21	7–9	Small spots
Chriomitra Lockington	*S. concolor*	..	..	16–18	..	15–17	16–18	7–9	16–20	7–8	Immaculate
Cybiosarda Whitley	*S. elegans*	45	4	9	..	15–16	16–17	9–10	15–16	7–8	Spots and horizontal stripes
Lepidocybium Gill	*S. flavobrunneus*	17 + 15 = 32	0	0	15	12	17–18	5	14–15	4–5	Immaculate
?	*S. croockewitii*	..	..	..	20	15	17	7	20	7	Broad stripe
?	*S. clupeoideus*	..	..	..	..	14	17	9	16	9	Immaculate
Maximum variations in Genus *Scomberomorus* Lacépède ..	..	32–51	0–4	0–18	15–23	12–22	15–21	5–10	14–21	4–10	



Text-fig. 1.—Diagram to illustrate the morphological relations and probable phylogenetic trends of world species of the genus *Scomberomorus* Lacépède.

The species are arranged on the diagram graphically in relation to the scale on the right to indicate the number of vertebrae in each; g.r. = number of gill-rakers and D_1 = number of spines in the first dorsal fin.

Generally speaking the branches *Sierra, Cybium, Sawara* and *Scomberomorus* have ratio of head length to body length small and number of dorsal fin spines large, while *Indocybium* and *Pseudosawara* have fewer dorsal fin spines and head length to body length relatively larger.

Geographical distribution shows that *C. commerson*, which morphologically resembles *Acanthocybium* in many ways, has been the most successful of modern Scomberomorids. The suggestion is that the type of body form adopted by *S. commerson* and *Acanthocybium* has proven the most suitable for life under oceanic conditions and for making long migrations. Those types which have developed in the opposite direction by shortening the head and increasing the body depth have had relatively less success and are restricted to shallow calmer coastal seas and their geographical range is limited.

THE AUSTRALIAN SPECIES OF SCOMBEROMORUS LACÉPÈDE.

The investigation of the Australian species of Spanish Mackerel has led to the establishment of the fact that there are four distinct species which belong to three subgenera. It has been generally accepted by Australian ichthyologists that there were three species in our waters. These are the Barred Spanish Mackerel or Giant Mackerel (*S. commerson* (Lacép.)), Grey Mackerel (*S. semifasciatus* (Macleay)) and some mysterious spotted variety hitherto erroneously recorded as *S. guttatus* (Bl. & Schn.). Examination of specimens in the Australian Museum collection and extensive field observations reveal that there is no species on the coast which has claim to the name *guttatus*. The "Spotted Spanish Mackerel" of Australian authors belong in reality to two distinct and easily recognisable forms; the discovery of one (*S. niphonius*) constitutes a new Australian record, whilst the other (*S. queenslandicus*) proves to be new to science.

These four species can be keyed out simply and distinguished from their close relatives *Acanthocybium* and *Grammatorcynus* as folows :—

KEY TO AUSTRALIAN SPECIES OF *SCOMBEROMORUS*.

1. Two lateral lines, body scaly .. .. *Grammatorcynus bicarinatus.*

2. Single lateral line, body scales very minute.

A. Spinous dorsal fin with 25-26 rays, jaws beak-like, gill-rakers absent, specialised scales above pectoral fin, lateral line with numerous long branches .. .. *Acanthocybium solandri.*

AA. Spinous dorsal fin with 14-20 rays, gill-rakers present, no great specialisation of corselet scales.

a. Gill-rakers rudimentary, never more than 1 + 6; teeth flat, compressed and minutely serrulate; 16-17 dorsal spines.

i. Body marked with numerous narrow wavy bands on belly; lateral line with sharp inflection below second dorsal finlet .. .. *Scomberomorus (Cybium) commerson.*

ii. Body marked with diffuse rounded blotches, each larger than diameter of the eye and arranged in about three rows below lateral line; lateral line without a deep inflection .. .. *Scomberomorus (Cybium) queenslandicus.*

aa. Gill-rakers well developed, 2 + 8 or 9; teeth slightly curved inwards but not serrulate.

i. Body marked with anastomosing spots about size of pupil of eye and confined to a band along middle of side; Spinous dorsal with 19-20 rays .. .. .. *Scomberomorus* (*Sawara*) *niphonius*.

ii. Body marked with a few broad straight vertical bands on its upper portion; Spinous dorsal with only 14 rays; head very small .. .. *Scomberomorus* (*Indocybium*) *semifasciatus*.

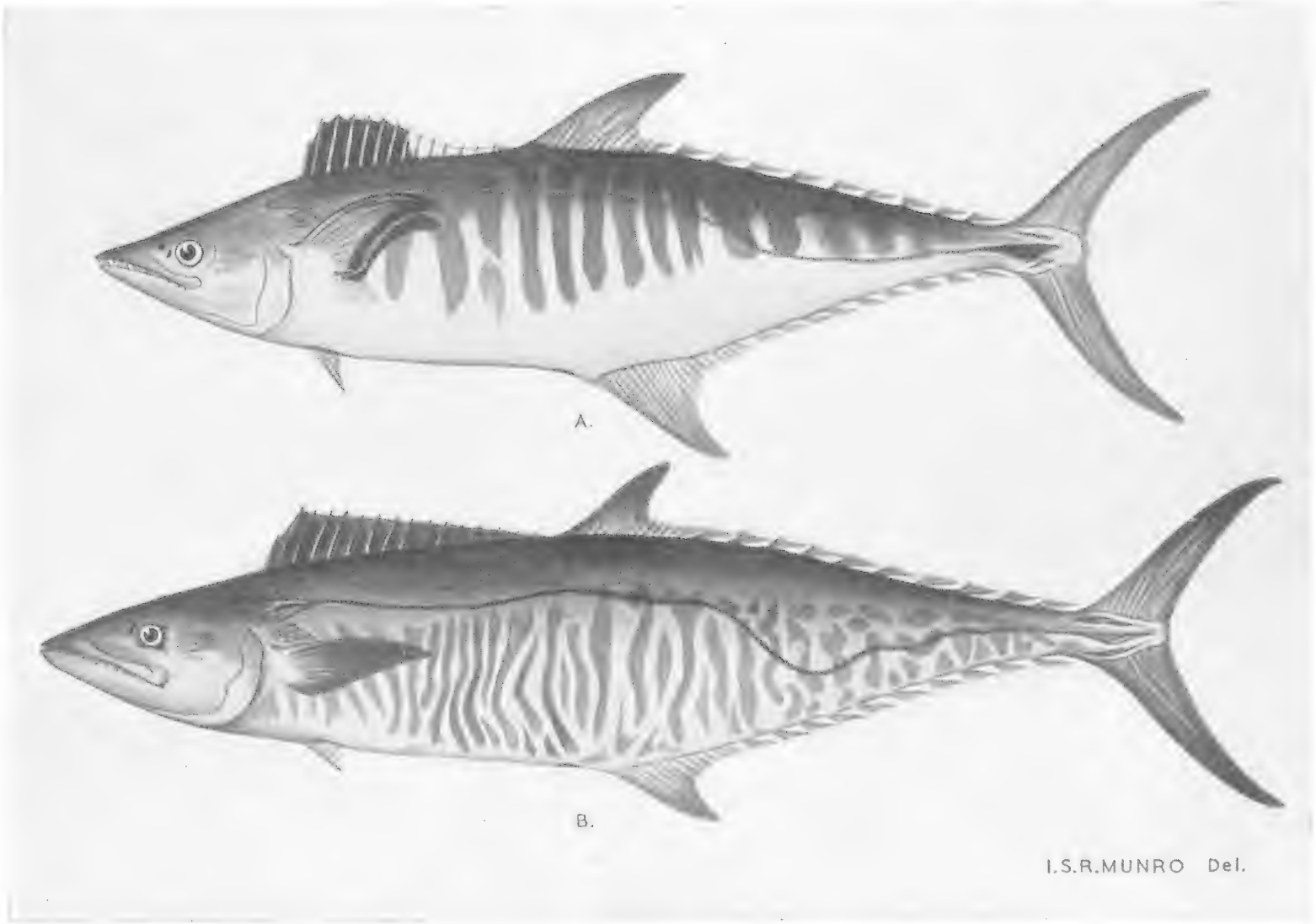
SCOMBEROMORUS (CYBIUM) COMMERSON (Lacépède) 1800.

NARROW-BARRED SPANISH MACKEREL.

Plate VI and VIII.

1. DISTRIBUTION.—If all records of this name apply to a single homogeneous species the distribution of *S. commerson* is wider than for any other species of the genus. It occurs at least seasonally throughout all waters in Indo-Australian Region, the Red Sea and the East coast of Africa. The extreme limits of geographical range are approximately 40° N. and 40° S. latitude. On the African coast its range is at least from Cape of Good Hope to Zanzibar, Mauritius (Type locality) and the Red Sea. It is well known in India, Ceylon, Bay of Bengal, Siam, Malaya, Singapore, China, Japan, Formosa, Phillipines, Sumatra and Indian Archipelago generally. In New Guinea waters it has been officially recorded from Aru Is. (Weber) and Hood Bay (Macleay) and there is a specimen in the Australian Museum (IA. 5679) from Eastern Papua (between Pt. Glasgow and Suau Is.). It is apparently very common in Torres Straits and there is reason to believe that it is known in North Australian waters (Pellew Waters, Paradice & Whitley) but I have seen no specimens to confirm this. Mr. J. Gregory, Field observer for C.S.I.R. Fisheries Laboratory, has confirmed the existence of this species along the West Australian coast where it is known as "Albacore" and there is a large specimen in the Perth Museum (116·6 cm.). Mr. Gregory's records are for Albrolhos Is., Geraldton, Sharks Bay, Dirk Hartog Is. and Rottnest Is. Dampier's "Fish of the Tunny kind" from Sharks Bay (Voy. New Holland, III, 1703, pl. 3, fig. 5, p. 162) may refer to this species. On the eastern Australian coast it is perhaps better known than anywhere else. It is abundant all along the coasts of Queensland and New South Wales, especially along the islands of the Great Barrier Reef. Fishermen seek it as far north as Princess Charlotte Bay and there is a specimen in the Australian Museum (I. 14566) from Cooktown. I have seen many thousands from fishing grounds between Cairns and Coffs Harbour. It is known to occur as far south as Pt. Jackson (specimens in Australian Museum—I. 9693, B. 584) and on one occasion to Port Phillip Bay (McCoy, 1890). Mr. Blackburn of C.S.I.R. Fisheries Laboratory tells me of a 9 lb. specimen caught in March 1938 off St. Helens, Tasmania. In the Pacific, records indicate Fiji Is. only (Jordan & Dickerson), but doubtlessly it is found at New Caledonia (*vide* Priday, 1942, "Walkabout," Jan. 1st), Solomon Is. and elsewhere. No records have ever come from New Zealand.

2. DESCRIPTION.—(*a*) *Size*—Age groups normally caught in winter months in Australian waters fall into two categories, namely 9 lb.-12 lb. and 30 lb. Occasionally fish weighing 50 to 60 lb. are caught in North Queensland and Western Australian waters and anything above this weight is of quite exceptional occurrence. Fish of 40-50 lb. weight measure 4 ft. 6 in. (140 cm.). They are known to grow to a length of about 6 ft. (90-100 lb.) in Australia and other parts of the world, but it is difficult to procure official records.



Australian Spanish Mackerel.

Fig. A.—*Scomberomorus* (*Indocybium*) *semifasciatus* (Macleay), Broad-barred Spanish Mackerel or Grey Mackerel. Specimen from Mackay district, North Queensland, 4th September, 1941. Queensland Museum Collection Registered No. I 7375. Length to caudal fork = 451 mm.

Fig. B.—*Scomberomorus* (*Cybium*) *commerson* (Lacépède), Narrow-barred Spanish Mackerel, Giant Mackerel, or Kingfish. Specimen from Cape Moreton, South Queensland, 4th August, 1941. Length to caudal fork=968 mm.

(*b*) *Colour.*—The following colour notes apply to freshly caught specimens from the Queensland coast :—Cranial regions and upper regions of back are mottled with iridescent blue and green with some purple and bronze colours giving a " shot " appearance which rapidly changes to deep blue. Below the level of the lateral line from the snout to the caudal fork the sides are a pale silver grey with some iridescent shades and marked with transverse vertical bars of a darker grey, these extending upwards into the darker zone above the lateral line where they fade away. These bars are narrow and slightly wavy and often break up into spots in the belly region. This condition is most marked in the bars nearest the tail and in young fish. There are about 40 or 50 such bands in mature fish but there is usually less than 20 in fish up to 18 inches long. The cheeks, lower jaw and belly region are silvery white. Spinous dorsal fin is bright blue with white spines which rapidly fades to a blackish blue. The pectoral fin is a light grey which likewise turns to a blackish blue. The caudal flukes, soft dorsal, anal fins, and dorsal and anal finlets are a pale greyish white colour which quickly turn to dark grey with a tinge of blue-green or yellow. In younger specimens the membrane of the spinous dorsal fin is pure white with contrasting jet black areas anteriorly.

(*c*) *Fin Formulae.*

TABLE II.—FIN COUNTS IN *S. commerson*. SERIES FROM QUEENSLAND WATERS.

No. of Spines and Rays.	8	9	10	11	14	15	16	17	18	19	21	22	23	24	Total No. Individuals.
1st Dorsal ..					3	6	28	3							40
2nd Dorsal ..							9	19	9	1					38
Dorsal Finlets ..		18	19	3											40
Anal					1	0	3	16	1						21
Anal Finlets ..	3	24	11												38
Pectoral											2	19	13	3	37

In the above table (II) is defined the range of variations of counts of spines in various fins of *S. commerson* from Queensland waters, namely :—

D, 14-17 ; 16-19 ; 9-11. A, 14-18 ; 8-10. P, 21-24.

From this can be drawn up a more usual or average fin formula, namely :—

D, 16 + 17 + 10. A, 17 + 9. P, 22-23.

It is of interest to note that the above, compiled from original observations on Queensland fish, is essentially similar to that recorded for the classical examples from other parts of this species world range. For comparison these figures are reproduced in table III. The fin formulae given in these descriptions all fall within the range of variation of Australian fish.

TABLE III.—FIN FORMULAE OF *S. commerson* FROM VARIOUS WORLD LOCALITIES.

D1	D2	D-Finlets.	A	A-Finlets.	P	Authority.	Locality.
16	16	10	16	9	22–23	Cuv. & Val. 1831	? Mauritius
16	16	10	16	10		Gilchrist & Thompson, 1909 ..	Natal Coast
16-17	15–17	9–10	14–17	9–10		Barnard, 1927	Sth. Africa
15–16	14–16	9–10	17	9–10		Klunzinger, 1871, 1884	Red Sea
16	14	10	17	10	24	Rüppell, 1828	Red Sea
16	16	10	14	12	22	Russell, 1803	India
16–17	16–18	9–10	14–16	9–10	20–23	Day, 1876, 1889	India
17	17	10	17	10	23	Cantor, 1850	India
15–16	16–17	9–10	17	9–11	23	Deraniyagala, 1933..	Ceylon
17	16	10	16	10		Kner, 1869	Manilla
16	17	10	14	9		Jord. & Seale, 1907	Philippines
17	15	9	14	9		Kishinouye, 1923	Japan and Formosa
16	17	9–10	17	9–10		Macleay, 1881	Pt. Jackson, Aust.
16	17	10	17	9	24	McCoy, 1890	Pt. Phillip, Aust.
15–16	15–17	9–10	15–17	9–10	22–23	Whitley, 1936	Queensland

(d) Body Proportions.

TABLE IV: BODY PROPORTIONS OF *Scomberomorus commerson*. SERIES FROM EAST COAST OF AUSTRALIA—NEW GUINEA TO PORT JACKSON. SIZE RANGE (L.C.F.) 368 mm. TO 1252mm.

Ratio.	Number of Specimens.	Observed Range.		Mean.	σ	Coefficient of Variation
		Minimum.	Maximum.			
Head length/snout length	42	2·19	2·53	2·36	0·072	3·0%
Head length/eye diameter	42	6·00	11·84	8·18	1·04	12·7%
Head length/inter-orbital	42	2·59	4·64	2·98	0·302	10·1%
Head length—maxilla length	42	1·66	2·14	1·75	0·079	4·5%
Head length/pectoral fin length	42	1·46	1·80	1·58	0·084	5·3%
Body length/head length	42	4·38	5·21	4·83	0·205	4·2%
Body length/snout to origin of 1st dorsal fin ..	40	4·06	5·09	4·51	0·206	4·5%
Body length/snout to origin of 2nd dorsal fin ..	40	1·78	2·15	1·96	0·058	2·9%
Body length/snout to origin of ventral fins ..	39	3·79	4·45	4·16	0·152	3·6%
Body length/snout to vent	39	1·68	2·06	1·98	0·067	3·4%
Body height/inter-axillary width	40	1·37	1·91	1·54	0·345	22·4%
Body length/body height at level of vent + height of 2nd dorsal fin + height of anal fin ..	38	2·03	2·92	2·69	0·156	5·8%
Body length/length of upper + length of lower caudal lobes	29	2·77	6·30	3·37	0·857	25·4%

In the above table (IV) are summarised ratios of various body proportions selected as being the more significant of those usually employed in the taxonomy of fishes. The principal variables are related either to body length (*i.e.* length from snout to caudal fork) or head length and many of the complex inter-relations used by ichthyologists are purposely omitted as being superfluous. In the above form of presentation it is easy to compare the body proportions with those of other species at a glance.

The definition of the measurements employed is to be found either in Russell, F.S. (1934), Journ. Mar. Biol. Assoc. XIX. 2, pp. 503-522 or in Cons. Internat. l'Explor. de la Mer, Rap. et Proc.—Verb., VII, 1932, pp. 47-68, and are those generally employed for Tuna. Measurement differs only in that all measurements were made with the aid of calipers and are those distances directly between the points of reference and are not made across the curvature of the body. Variation between the above series of values and those given for this species by authors from overseas can be attributed to rough measurements made from different points of reference. The body length is taken as that distance between tip of snout to posterior edge of central rays of caudal furca. Head length is that distance between tip of snout and most distant point on the free hinder edge of the operculum or gill cover. Body height is measured at level of first ray of spinous dorsal fin.

To fully define the variations met with in all of the chosen body proportions the minimum and maximum observed limits of variation are given. For complete definition of the variations shown in each proportion the Arithmetic Mean (M) and the Standard Deviation (σ) have been calculated.

The Coefficient of Variation (V) or Standard Deviation expressed as a percentage of the mean is employed here as an index to homogeneity or heterogeneity within the species. This is to be interpreted from the degree of variability of the above body proportion relationships in respect of a series of 42 examples of *S. commerson* from the east coast of Australia. Simpson and Roe, " Quantitative Zoology," 1939, have defined the normal value of V as being between the limits of 4 and 10 in a homogeneous series. It will be noted that only six of the above thirteen ratios satisfy this requirement. The lower values in four other ratios may signify that the sample is not sufficiently large to demonstrate the full range of variability and this might

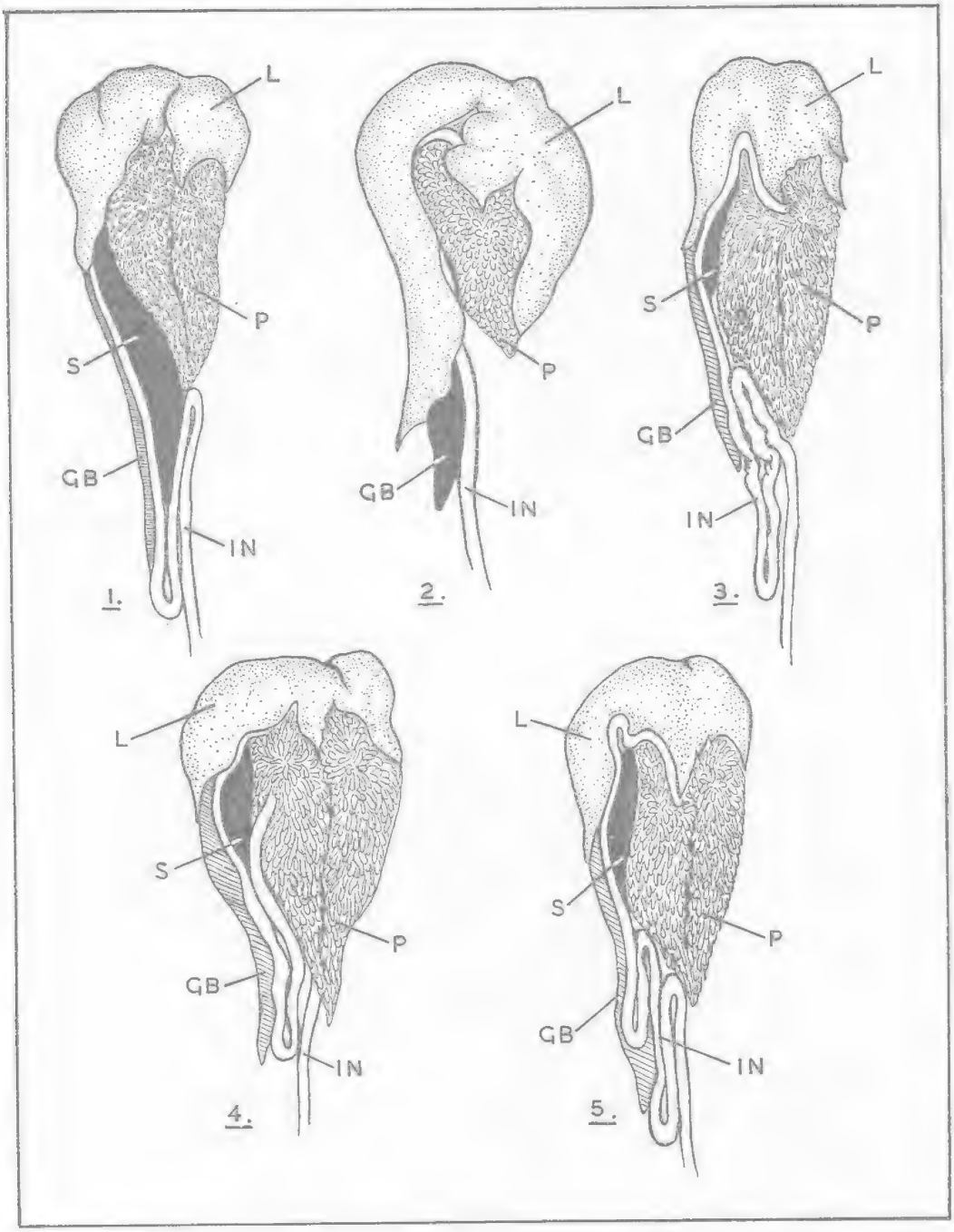
find its explanation in the fact that examples of less length than 368 mm. are not included in the above series. The higher value of 12·7 per cent. for ratio of head length/ eye diameter might not be of great significance and would appear to be insufficient to suggest racial variation. That Queensland fish are racially homogeneous is further illustrated by the fact that when any of the twenty-three part measurements defined by Russell (1934) are graphed against body length, all measurements fit along the same line. Body proportions would suggest that no racial variations of this species occur along the east coast of Australia. The higher degree of variability exhibited in the ratio of body height/interaxillary width can be interpreted as due to seasonal or sexual condition.

Body proportions of Australian examples compare fairly well with those given for this species from other world localities, namely Red Sea, Natal, Ceylon, China and Philippine Islands. Some divergence is apparent but accurate measurements for large series are required for comparison with Australian forms before it is possible to define any racial differences attributable to geographical causes.

(*e*) *Internal Anatomy.*—The liver is divided into three uneven lobes, of uniform pale brown colour and small in size compared with the mass of the pyloric caecae. The spleen and gall-bladder are long narrow organs. The lower intestine is bent upon itself in four places, thus forming four loops. The shapes and disposition of these organs is as illustrated in Text-figure 2, no. 4. Kishinouye (1923, Journ. Coll. Agric., Tokyo, VIII, pp. 410, 417) describes this fish with a swim-bladder present. I have been unable to detect any structure in Australian specimens which in any way resembles a swim-bladder. In order to search for this organ the visceral cavities of many examples have carefully been opened in the field. There is apparently no swim-bladder in the Australian race of this species. The significance of this difference is questionable. On one hand it might mean that there is a specific, or at the very least, a racial difference between the fishes of Japanese seas and those inhabiting our own coastal waters. At the same time it is quite possible that Kishinouye may have confused this structure with some loose peritoneum in his Japanese example. Apart from this difference in observation, there does not seem to be any special reason for separating these two geographical races as distinct species or even varieties.

(*f*) *Gill-rakers.*—The gill-rakers in *S. commerson* are small rudimentary structures and can have little if any functional value. They are very few in number. The upper limb of the first gill-arch has usually a single raker. This may be absent altogether and in rare cases there is a second incipient raker. There are usually 4 or 5 rakers on the lower limb of the first gill-arch in Australian examples. The most usual or average gill-raker formula can be taken as 1 + 4. The extreme variation is—upper limb = 0–2, lower limb = 3–6. The gill-arch has been illustrated by Delsman and Hardenberg (1934, Ind. Zeevisscherij en Zeevisschen, fig. 264, c.). *See also* Text-fig. 3, no. 1.

(*g*) *Lateral-line.*—The lateral-line of this species has a characteristic shape which becomes more accentuated with age, namely there is a deep inflection in the region below the second to fifth dorsal finlets. The lateral-line descends very gently and undulating only slightly until it passes the posterior end of the soft dorsal fin. It then dips very suddenly below the level horizontal with the caudal lateral keels. At the level of the fourth to fifth dorsal finlets the lateral-line has again risen to the level of the above-mentioned horizontal and follows that horizontal in an undulating



Text-fig. 2.—Arrangement and proportions of the principal components of the viscera of—

(1) *Scomberomorus* (*Sawara*) *niphonius* (Bramble Reef, North Queensland).
(2) *Grammatorcynus bicarinatus* (Watt Reef, North Queensland).
(3) *Scomberomorus* (*Indocybium*) *semifasciatus* (Townsville, Queensland).
(4) *Scomberomorus* (*Cybium*) *commerson* (North Palm Island, North Queensland).
(5) *Scomberomorus* (*Cybium*) *queenslandicus* sp. nov. (Maryborough, Queensland).

L = liver; P = pyloric caecae; S = spleen; GB = gall-bladder; IN = lower intestine.

course till it disappears in the region of the lateral keels. There are about 220 to 240 scales along the lateral-line in Queensland examples of this species. Kishinouye (1923) has given this value as 230 in Japanese specimens. It has been noticed that in the larger age groups of this species, *i.e.* examples exceeding 3 feet in length and weighing about 30 pounds, there is a vestigial branching of the main lateral-line canal. This has also been noticed by Deraniyagala (1933) in examples from Ceylon. The branch canals are quite distinct and resemble those of *Acanthocybium solandri* in structure but are restricted in length to about one quarter of an inch. They are present only in older fish. Structurally they are composed of definite tubules bordered with scales and distinctly different to the furrowing of the skin in *S. kuhlii* or *S. koreanus* and the "Pseudo-branching" effect of a scale fringed lateral-line as in *Sawara niphonia*. In *S. commerson* and *Acanthocybium solandri* there is true ramification of the main lateral canal.

(*h*) *Vertebrae.*—It has been possible to make a vertebral count in only two Australian examples of *S. commerson*. Both are from the Queensland coast and have a total of 45 vertebrae, excluding the hypural. This number is comprised of 20 precaudal vertebrae and 25 caudal vertebrae. This formula, namely $20 + 25 = 45$ is identical with that given by Kishinouye (1923) for Japanese examples.

3. Synonymy.

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Scomber commersoni Bloch (ed. Schneider), Syst. Ichthyol., 1801, pp. 545-546, (ex Lacépède)

Scomber commersonii Shaw, Gen. Zool. iv, 2, 1803, pp. 589-590, pl. LXXXV, f. 2 (after Lacépède, "Pacific Ocean"); Schinz, Theirreich von Cuvier, 1822, p. 506 footnote; Gill, Proc. Acad. Nat. Sc. Philad., 1862, p. 126.

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Scomberomorus (*Scomberomorus*) *commersoni* Deraniyagala, Ceylon J. Sci. (B), xviii, 1, 1933, p. 40, pl. I, f. 1, text-fig. 1 (Ceylon).

Scomberomorus commersonii Swain, Proc. Acad. Nat. Sc. Philad., 1883, p. 306 ; Ogilby, Rept. Dept. Harb. & Mar., Qld., 1905, p. 12 (Moreton Bay) ; Waite, Mem. N.S.W. Nat. Club, 2, 1904, p. 42 ; Jordan & Dickerson, Proc. U.S. Nat. Mus., xxxiv, 1908, p. 610 (Suva, Fiji) ; Stead, Edible

Fishes N.S.W., 1908, p. 98 (in part only—*not* pl. LXVI = *S. semifasciatus*); Roughley, Fishes Aust., Tech. Mus. Sydney, 21, 1916, p. 162; Gilchrist & Thompson, Ann. Durban Mus., i, 4, 1917, p. 395; McCulloch, Austr. Zoologist, ii, 3, 1921, p. 104, f. 292a; McCulloch, Aust. Zool. Soc. Handb. i, 1922, p. 79, f. 292a (N.S.W.); McCulloch & Whitley, Mem. Qld. Mus., viii, 2, 1925, p. 142; Whitley (in Musgrave) Austr. Zoologist, iv, 4, 1926 (Nor'West Is., Q.); Marshall "Anglers Guide," 1934, p. 36 (Qld.); Wood, Coun. Sci. Ind. Res. (Aust.) Fish Circ. 2, 1940, p. 21, pp. 40-41.

Scomberomorus konam Bleeker, Nat. Tijds. Ned. Ind., i, 1851, p. 357 (Indian Archipel.); Seale, Philip. Journ. Sci. (A), iii, 6, 1908, p. 515 (Philippines).

Cybium commersonii Saville-Kent, Food Fishes Qld., 1889, pp. 5, 10, 11, Pl. X, f. 36.

4. General Discussion on Diagnosis.—The above synonymy of *S. commerson* calls for some comment when the extent of the geographical range of this species is realised. From a thorough perusal of the published descriptions and illustrations (as listed in above synonymy), it would appear that there is but a single species referred to in this mass of world literature that has been accumulating during three centuries.

It would appear that the first published record of this species is that of Dampier (Voyage to New Holland, III, 1703, p. 162, pl. III) who briefly described and crudely illustrated "A fish of the tunny kind" from the Sharks Bay district of Western Australia. The first recognised description is that of Lacépède (1800) but it is vague and comprises part of his general description of the genus. His description is based on a drawing in the Manuscripts of that eighteenth century traveller and naturalist, Philbert Commerson. Upon this description and illustration are based those of Bloch and Schneider (1801) and Shaw (Gen. Zool., 1803). There can remain no doubt that the "Konam" of Russell (1803, Fish. Vizag., i, p. 27) and the *Scomber maculosus* of Shaw (1803) and Shaw & Nodder (1811) from Indian seas refer to this same species. That these fish are conspecific was confirmed by Cuvier & Valenciennes (1831, Hist. Nat. Poiss., VIII, p. 165) who had the opportunity of comparing material from India and Mauritius with the MS. description of Commerson, not seen by Lacépède. It was Cuvier & Valenciennes that established the fact that Commerson's fish came from Mauritius, which must therefore be considered as the type locality of *S. commerson*. As far as records show there is no type specimen preserved.

Seale (1908) Philip. Journ. Sci, (A), iii, 6, p. 515, holds that *S. konam* and *S. commerson* are distinct species and that both occur in the Philippine waters. This is apparently based on the views of Bleeker, who consistently held that both species occurred in Indian and East Indian seas. However, as careful examination of Bleeker's original latinised description of *Cybium konam* (Nat. Tijds. Ned. Ind., i, 1851, p. 357) reveals that it fits in all details the body proportions, colour and fin-formulae of *S. commerson;* there remains little justification for considering these separate species. Until such time as someone can show just where *S. konam* and *S. commerson* differ, it is only reasonable to consider them conspecific.

As the distribution of this species is so large it is quite probable that several geographical races exist, but it is impossible to detect significant differences from the descriptions of *S. commerson* from the various regions of its distribution. The fish from the Red Sea as described by Rüppell (1828, 1835) and Klunzinger (1871, 1884) fit well enough the above description of the Australian form. Likewise do the descriptions and figures of this species from S.E. Africa and Indo-Japanese waters. Regarding the Indian form I have seen only two specimens which can be identified as this species, namely two immature fishes from Madras. These are in the Australian

Museum collection (B. 8208, "*C. commersonii*" & B.8116, "*S. guttatus*") and apparently were purchased from Mr. Francis Day. Both examples are undoubtedly of the same species and resemble our local *S. commerson* in respect to all principal characters and individualities.

Of Australian identifications, most appear to refer to a single species and most diagnoses are correct. A few have been confused with *S. semifasciatus*, especially young specimens. Fin formulae and gill-raker counts are always sufficient for distinguishing between these two species. For purposes of comparison a young specimen of *S. commerson* is illustrated in Plate VIII. The specimens in the Australian Museum that are identifiable as *S. commerson* are I.9693 (Pt. Jackson, upon which apparently is based the first description of an Australian specimen by Macleay, 1881), B.584 (Pt. Jackson), IA.5679 (E. Papua), I.14566 (Cooktown). Two specimens of small size (IA.7669, IA.7670) from Northern Territory collected by M. Ward and four very immature examples (I.5296-I.5299) from Darwin, N.T. though labelled "*S. commerson*" have been wrongly identified—all are typical *S. semifasciatus*. One other example (I.15275) is apparently that figured by Stead (1908, Ed. Fish N.S.W., pl. LXVI) and is another typical *S. semifasciatus*.

SCOMBEROMORUS (CYBIUM) QUEENSLANDICUS sp. nov.

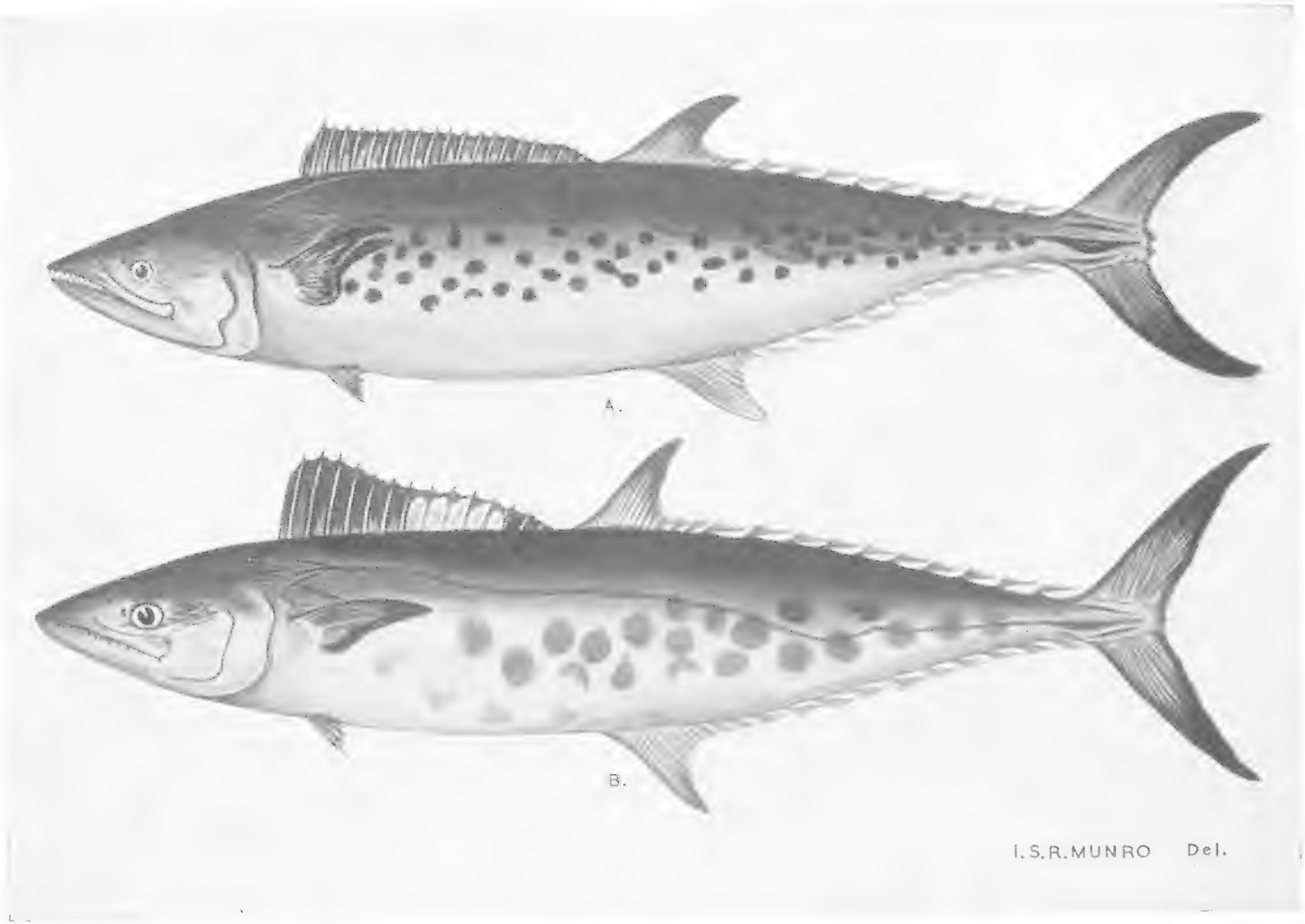
QUEENSLAND SCHOOL MACKEREL.

Plates VII & VIII.

1. Distribution.—This species, though new to science, is very common along the Queensland coast. It occurs along the West Australian coast also. It is essentially an estuarine fish caught by nets and by trolling in all the inlets between Brisbane and Townsville. The range of this species is probably greater and there is evidence to suggest that Macleay's specimen identified as *C. guttatum* from Pt. Jackson belongs to this species. It has been known to South Queensland fishermen for over sixty years as "School Mackerel" and has been sold in the Brisbane Fish Markets as such ever since their foundation. A skeleton with descriptions and an illustration supplied by Mr. J. Gregory confirms the existence of this species in West Australian waters. Mr. Gregory's record refers to Sharks Bay. There is no data available for Northern Australia. It is safe to consider the geographical distribution as being the East and West coasts of Australia between the latitudes of 10° S. and 30° S. No species identifiable as this is known from overseas.

2. Description.—(*a*) *Size.*—This species apparently reaches maturity at small size. It is the smallest of Australian Scomberomoridae. Examples of about 500 mm. length and weighing 3 or 4 pounds are average size. The age groups normally caught in Queensland waters vary from 300 mm. to about 750 mm. in length and these probably represent at least three age groups.

(*b*) *Colour.*—In freshly caught specimens the colours are as follows:—Cranial regions and upper part of the back are an iridescent bluish green and the cheeks and belly are a silvery white. In adult fish the sides are marked with about three indefinite rows of bronze-grey indistinct blotches, each a little larger than the orbit. The membrane of the spinous dorsal fin is jet black with large contrasting areas of intense white between the sixth and last spines. The second dorsal fin and the finlets are pearly grey with darker margins. The caudal fin is of similar colour. The ventrals, anal fin and anal finlets are white. The pectoral fins are greyish, being darkest on their inner surface.



Australian Spanish Mackerel.

Fig. A.—*Scomberomorus (Sawara) niphonius* (Cuv. & Val.), Spotted Spanish Mackerel. Specimen from Mackay district, North Queensland, 26th September, 1941. Length to caudal fork = 795 mm.

Fig. B.—*Scomberomorus (Cybium) queenslandicus* sp. nov., School Mackerel or Blotched Spanish Mackerel. Specimen from Moreton Bay, South Queensland, 25th July, 1942. Length to caudal fork = 545 mm.

Apparently the body markings alter with age. A small example of 95 mm. length is included in the Queensland Museum collection (Reg. No. I.7073) and this lacks the bronze-grey blotches of older fish. There are no markings on the belly, but along the back (*see* Plate VIII) are about twelve broken bars of a greyish colour. This growth change of colour pattern contrasts strongly with the constancy of markings in *S. semifasciatus* where the markings change but little with age.

(*c*) *Fin formulae.*—The fin formula is almost the same as that of *S. commerson.* This makes it difficult to separate the two species in old museum specimens from which the markings have faded. The range of variation in fin counts is shown in the following frequency table (V) :—

TABLE V.—FIN COUNTS IN *S. queenslandicus.* SERIES FROM QUEENSLAND WATERS.

No. of Spines and rays.	9	10	15	16	17	18	19	20	21	22	23	Total Number of Individuals.
1st Dorsal			1	16	6							23
2nd Dorsal				2	6	9	4	2				23
Dorsal Finlets	9	12										21
Anal			1	0	2	6	9	4				22
Anal Finlets	9	12										21
Pectoral								1	10	10	1	22

From the figures shown in Table V it is possible to define the range of variation in the principal fins as :

D, 15-17 ; 16-20 ; 9-10. A, 15-20 ; 9-10. P, 20-23.

The average fin formula (*i.e.* modal) can be taken as :—

D, 16 + 18 + 10. A, 19 + 10. P. 21-22.

This formula differs significantly from that given for *S. commerson* only in that there are on the average a few more rays in the anal fin of this species, *i.e. S. queenslandicus* = 19, and *S. commerson* = 17. It is almost impossible in practice to separate these two species on the basis of fin formulae alone. The shape of all fins are similar and normal in both species.

(*d*) *Body proportions.*—

TABLE VI. : BODY PROPORTIONS OF *Scomberomorus queenslandicus.* SERIES FROM EAST COAST OF AUSTRALIA—TOWNSVILLE TO PT. JACKSON. SIZE RANGE (L.C.F.) 288mm. TO 601mm.

Ratio.	Number of Specimens.	Observed Range.		Mean.	σ	Coefficient of Variation.
		Minimum.	Maximum.			
Head length/snout length	21	2·40	2·85	2·50	0·133	5·3%
Head length/eye diameter	21	5·25	8·41	7·33	1·036	14·2%
Head length/inter-orbital	21	2·74	3·31	3·05	0·175	5·7%
Head length/maxilla length	21	1·68	1·80	1·74	0·031	1·8%
Head length/pectoral fin length	21	1·58	2·22	1·79	0·161	8·9%
Body length/head length	21	4·25	5·09	4·55	0·240	5·3%
Body length/snout to origin of 1st dorsal fin ..	21	4·12	4·49	4·11	0·216	5·3%
Body length/snout to origin of 2nd dorsal fin ..	21	1·93	2·08	1·99	0·047	2·3%
Body length/snout to origin of ventral fin ..	18	3·93	4·35	4·11	0·110	2·7%
Body length/snout to vent	20	1·85	2·09	1·98	0·059	2·9%
Body height/inter-axillary width	12	1·48	2·00	1·74	0·129	7·4%
Body length/body height at level of vent + height of 2nd dorsal fin + height of anal fin ..	20	2·43	2·86	2·61	0·103	3·9%
Body length/length of upper + length of lower caudal lobes	10	2·72	3·31	3·09	0·156	5·0%

For comparison of the body proportion ratios of *S. commerson* and *S. queenslandicus* reference is made to Tables IV and VI respectively. It will be noted

that all the ratios show a close similarity in each species. This similarity gives support for the inclusion of the two species in the same subgenus, namely *Cybium* J. & H. The ratios are hardly sufficiently dissimilar to be used as indices by which to separate the two species, but there are some significant differences between certain of these ratios in subgenus *Cybium* and *Scomberomorus* (*Indocybium*) *semifasciatus*. Of the slight differences between *S. commerson* and *S. queenslandicus* it can be noted that :—

(1) The snout is slightly shorter than in *S. commerson*.
(2) The eye diameter larger than in *S. commerson*.
(3) First dorsal fin inserted slightly further back than in *S. commerson*.
(4) The caudal fin very slightly larger than in *S. commerson*.

It can be seen that some of the values for Coefficient of Variation are rather low, *i.e.* less than 4. This condition is comparable to that exhibited by *S. commerson*. The significance may not be as great as Simpson and Roe have indicated. As suggested by Serventy (1942, Journ. Coun. Sci. Ind. Res. (Aust.), xv, 2, p. 104) the possession of a low intrinsic variability by some ratios might be interpreted as signifying that the magnitude of these is remarkably constant. Their values would therefore be useful as specific characters. With the exception of the ratio head length/eye diameter, all coefficients of variation have a value of less than 10. This would suggest that the material comprising this series is quite homogeneous. From this examination of body proportion ratios it can be concluded that there is no indication of the existence of local races or varieties of this species of Spanish Mackerel.

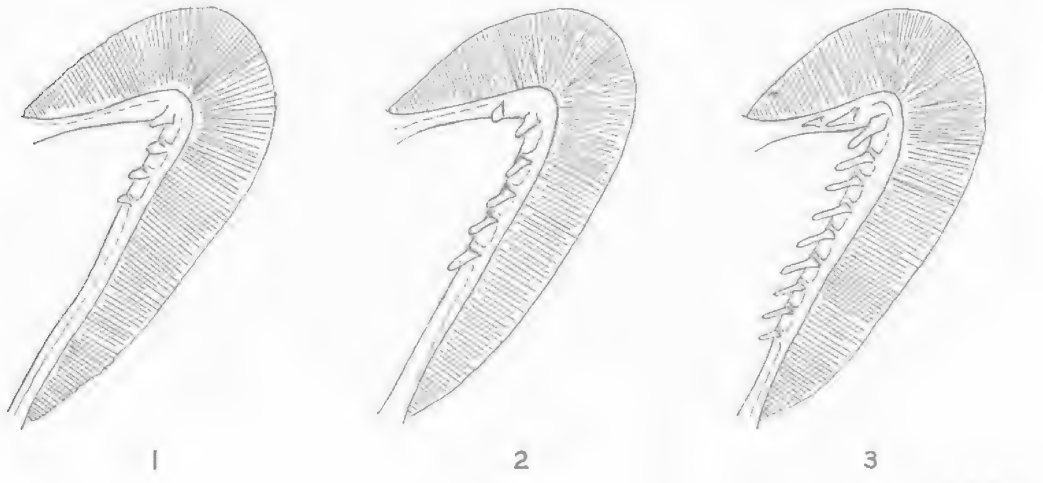
(*e*) *Internal Anatomy.*—It is also difficult to tell the difference between *S. queenslandicus* and *S. commerson* with reference to the internal anatomy only. The liver, spleen and gall-bladder have much the same shape and proportions in both species. The liver is tri-lobed as in other species of the genus. The lower intestine has four loops as in *S. commerson* but in this respect differs from *S. semifasciatus* and *S. niphonius*. This character may have subgeneric significance. The stomach bag has usually 12 folds on its inner surface. There does not appear to be any swim-bladder. The viscera is illustrated in Text-figure 2, No. 5 (young specimen).

(*f*) *Gill-rakers.*—The gill-rakers are short processes but not quite such rudimentary structures as found in *S. commerson*. Their number is slightly greater. As in other species this number is subject to variation. On the upper limb of the first arch there is at most one rudimentary raker and this is very often altogether absent. There may be from 4 to 7 short rakers on the lower branch of the first arch but 5 or 6 is more usual. The gill-raker formula is thus $0 + 4$ to $1 + 7$ and $0 + 6$ is very common. The first gill-arch (left) is illustrated in Text-figure 3.

(*g*) *Lateral-Line.*—As a general rule the lateral-line is not very wavy and lacks the deep inflection under the first four dorsal finlets possessed by *S. commerson*. It descends gently to a point beneath the first two or three dorsal finlets and then pursues a horizontal course to the caudal peduncle. The lateral-line is not branched and is composed of a variable number of scales, the number of which seems to vary from about 180 in young examples to about 220 in older age groups.

(*h*) *Vertebrae.*—Examination of the skeletons of nine specimens from the east coast of Australia reveal that in eight of these there are $20 + 28 = 48$ vertebrae. The ninth has $20 + 29 = 49$. The average count for the eastern Australian fish can be taken as being 48 vertebrae comprising 20 precaudal vertebrae and 28 caudal

not including the hypural joint. The only specimen that I have seen from Western Australia (Sharks Bay) shows a slight variation in this count—not in the total count, but there is one less precaudal vertebra and one more caudal vertebra, *i.e.*



Text-fig. 3.—Gill arches showing gill-rakers in three species of Spanish Mackerel—
(1) *Scomberomorus* (*Cybium*) *commerson* (Lacépède).
(2) *Scomberomorus* (*Cybium*) *queenslandicus* sp. nov.
(3) *Scomberomorus* (*Indocybium*) *semifasciatus* (Macleay).

19 + 29 = 48. This slight variation may be significant in that it might indicate the existence of two races of this species, one from the east coast and the other from the west. It would be foolish to conclude this from such little material.

3. Comparison with Other Species.—For the purposes of general comparison of the principal morphological features of this species with those of other known world species, Table I should be referred to.

The possession of 16 spines in the first dorsal fin, broad flat minutely serrulate teeth and a restricted number of gill-rakers of a rudimentary type is sufficient to separate this new species from all other known valid species in the world with the exception of *S. commerson*. The possession of this particular combination of characters enables us to set apart these two species (*S. commerson* and *S. queenslandicus*) in a distinct subgenus *Cybium* J. & H. Further, *S. queenslandicus* can be distinguished from *S. commerson* as follows :—

Table VII. Differences in principal characters of *S. commerson* and *S. queenslandicus*.

Character.	*S. queenslandicus.*	*S. commerson.*
1. Vertebral count	20 + 28 = 48	20 + 25 = 45
2. Markings	About three rows of diffuse blotches.	Numerous wavy vertical bands on belly.
3. Lateral-line	Not deeply inflected.	Deep inflection below 2nd & 3rd dorsal finlets.
4. Anal fin count	17-20. mode at 19.	16-18, mode at 17.
5. Gill-rakers	Normal = 1 + 6.	Normal = 1 + 4.

4. General Discussion on Diagnosis.—Although new to science, this species has not altogether escaped the notice of Australian ichthyologists but in the past has been erroneously identified. It has been confused with the young of *S. commerson* and even with *S. semifasciatus*. In most cases it has passed under the name of *S. guttatus* (Bloch & Schneider). *Scomberomorus guttatus* is a form restricted in distribution to India and the Indian Archipelago and does not resemble *S. queenslandicus* very closely but is more like our *S. semifasciatus*. The true *S. guttatus* does not occur in Australian waters and must be struck off all our Australian Check Lists of Fishes. Its synonymy is rather confused, principally with *S. queenslandicus* and *S. kuhlii* (C. & V.). True *S. guttatus* is that described and figured by Bloch & Schneider (1801, Syst. Icth.), Russell (1803, Fish. Vizag., II), Cuvier and Valenciennes (1831, Hist. Nat. Poiss, VIII), Day (1876, Fish. India), Maxwell (1921, Malayan Fish.) and Delsman & Hardenberg (1934, Ind. Zeevisscherij en Zeevisschen, fig. 274). Other descriptions are questionable. The *S. guttatus* of Kishinouye (1923 Journ. Coll. Agric. Tokyo) and Deraniyagala (1933, Ceylon J. Sci. (B), xviii) belong to the similarly spotted Indo-Japanese *S. kuhlii* C. & V. True *S. guttatus* has about five rows of smaller spots, 2 + 11 gill-rakers and has much the same body proportions as *S. semifasciatus*, namely small head, large tail and predominant dorsal and anal fins. Morphologically it is quite unlike *S. queenslandicus*.

Rendahl's *S. guttatus* is not *S. queenslandicus* but unquestionably *S. semifasciatus* (K. Svenska, Vet. Akad. Handl., LXI, 9, 1923, W. Australia). The specimen described by Macleay (1881, Desc. Cat. Aust. Fish., p. 193) from Port Jackson is apparently *S. queenslandicus*, as are also the fish described by Stead (1908, Edible Fish. N.S.W.), (1906, Fish. Aust.). The example (I.15026) presented by Stead to the Australian Museum and labelled "*S. guttatus*" is a typical *S. queenslandicus*, as are also the following specimens in the collection of that institution—IA.56, IA.1598 from Cairncross Is., I.15276, and IA.6573, from Cumberland Grp. Of the series in the possession of the Queensland Museum the following are typical *S. queenslandicus*:—I.5994 from Moreton Bay, I.6580, I.6588 from C. Cleveland, N. Qld., and I.7266 from Moreton Bay.

5. Type Specimen.—The holotype has been selected for convenience from the series in the Queensland Museum Collection. The holotype is thus designated as specimen, Qld. Mus. Reg. No. I.6588 from Cape Cleveland, North Queensland. This specimen was collected and presented to the Museum by Mr. G. Coates of Townsville. This example measures 464 mm. Its fin formula is D. 17 + 19 + 9; A. 20 + 9; P. 22. Gill-rakers 0 + 6. Scale row (lateral-line) = 180. Teeth—upper jaw = 34, lower jaw = 20. Length of head = 101 mm.; length of snout = 42 mm.; diameter of eye = 13 mm.; length of maxilla = 59 mm.; interorbital distance = 36 mm.; height at level of anus = 83 mm.; length of pectoral fin = 57 mm.; height of first dorsal spine = 28 mm.; height of soft dorsal fin = 52 mm.; height of anal fin = 50 mm.

SCOMBEROMORUS (SAWARA) NIPHONIUS (Cuvier & Valenciennes) 1831.

SPOTTED or JAPANESE SPANISH MACKEREL.

Plate VII.

1. Distribution.—That this species occurs in Queensland waters has never before been appreciated nor put on record by ichthyologists. However it is quite well known from the seas of China and Japan. As far as records show the distribution in the Northern Hemisphere is roughly limited by the parallels of 25° N. and 45° N.

along the coast of China, Korea, and both coasts of Japan. In Australian waters the known limits are 18° S. to 30° S. approximately and restricted to the east coast *i.e.* from Palm Is., N. Qld. to Coff's Harbour, N.S.W. It is caught principally in shallow waters over reefs close inshore but has also been caught along the Great Barrier Reef. It is fished in small numbers on North Queensland fishing grounds from October onwards but in larger numbers in South Queensland and northern N.S.W. from December until April and May.

2. DESCRIPTION.—(*a*) *Size.*—The examples of this species which I have examined vary in length (*i.e.* snout to caudal fork) from 56 cm. to 101 cm. The average run is of 70-90 cm. in length and weighing from 7 to 10 lb. There are apparently several age groups represented in the catches of fishermen along this coast. Generally speaking the examples of this spotted species are larger in size than those of the other Australian spotted species *S. queenslandicus*.

(*b*) *Colour.*—In freshly caught specimens the colours are as follows :—Cranial regions and upper part of back are of a darkish blue. The sides are a light silvery grey marked with three or four indefinite rows of dark grey spots along the region of the lateral line. These spots are rounded or irregular in shape and about the size of the pupil of the eye (ca. $\frac{3}{8}$-$\frac{1}{2}$ in. diameter). The cheek plates and belly are of silvery white. There is a pale but distinctive purplish sheen over most of the body of freshly caught fish and this is especially noticeable on the belly. The spinous dorsal is of a bright steely blue with a mottling of white throughout. There are white blotches on the membrane near the bases of the more posterior spines while there are areas of darker grey near the tips of the spines. The second dorsal fin and dorsal finlets are of a dull grey as also are the caudal flukes. Anal fin is light silvery grey with white near its tip. Anal finlets are silvery grey. Inside surface of pectoral fin is dark blue as on back and outer surface dark silver grey. Ventral fins silver white internally but greyish on the outside. The body colours lose their brilliance and fade to various shades of grey after death.

(*c*) *Fin Formulae.*—Not a great deal of material has been available for this study but a fairly good idea of the range and variation of fin counts in Australian specimens can be gleaned from the following table (VIII) :—

TABLE VIII : FIN COUNTS OF *Scomberomorous niphonius*. SERIES FROM QUEENSLAND COAST.

No. of spines and rays.	9	10	15	16	17	18	19	20	21	22	23	Total Number of individuals.
1st Dorsal								7	8	1		16
2nd Dorsal				2			1					3
Dorsal Finlets	2	1										3
Anal			1		1	1						3
Anal Finlets	3											3

The fins have a range of variation in respect to number of constituent spines according to the following formula :—

D, 20-22 + 16-19 + 9-10 ; A, 15-18 + 9. P, 23.

This formula compares well enough with that given in the descriptions of this species (*S. niphonius*, *S. gracilis*) by other authors. For comparison Table IX is

included setting out these counts as extracted from the classical descriptions of this fish :—

TABLE IX. FIN COUNTS OF *S. niphonius* AND *S. gracilis* FROM CHINA AND JAPAN.

—	D_1	D_2	Dorsal Finlets.	A.	Anal Finlets.	P.	Authority.	Locality.
C. gracile ..	20	16	9	18	8		Günther 1873	Chefoo
S. gracilis ..	20		8	17	8		Tortonese, 1939	Yokohama
C. niphonium	20	16	8	14	8		Temminck & Schlegel, 1850. Günther, 1860	Japan
C. niphonium	20	16	8	17	8	21–23	Tanaka, 1912	Japan
C. niphonium	19	15	9	15–17	8		Kishinouye, 1923	Japan
C. niphonium	20	16	8	16	8–9		Fowler, 1936	Japan

Of the fins, the spinous dorsal calls for special comment. It is relatively long, low and its upper edge almost straight. The abnormally large number of spines (usually 20 or 21) makes it easy to distinguish this species from all other Scomberomorids. It is this feature in particular that calls for the separation of *Sawara* as a separate subgenus.

The pectoral fin has also a distinctive shape in that the posterior margin is deeply excised forming two distinct lobes. This feature is more pronounced than in any other known species of *Scomberomorus*.

(*d*) *Body proportions*.—Data on body proportions is available for one specimen only. It is impossible therefore to indicate the range of variation, or define it in terms of the mean and standard deviation, for the recognised ratios. The following table (X) is given for comparison of the body proportions of a single Australian example (from Mackay) with those given for Sino-Japanese specimens in the various published descriptions.

TABLE X. BODY PROPORTIONS OF AN AUSTRALIAN EXAMPLE OF *Scomberomorus niphonius* (795mm.) COMPARED WITH THOSE OF SINO-JAPANESE SPECIMENS.

Ratio.	Qld. (Mackay).	*S. niphonius.*			*S. gracilis.*
		Temminck & Schlegel 1884.	Tanaka 1912.	Fowler 1936.	Tortonese 1939.
Body length/head length	5·49	5·0	4·7	4·0–4·2	5·0
Body length/body height	5·56	5·5	5·12	4·75–5·0	6·0
Head length/snout length	2·42		2·5	2·9–3·0	
Head length/eye diameter	9·88		7·75	4·0–5·0	7·0
Head length/maxilla	1·87		1·8	1·75–1·8	
Head length/pectoral fin	1·92		2·2	1·8–2·0	2·0
Head length/height of 2nd dorsal fin	1·70		2·4	2·75–3·0	
Head length/height of anal fin	1·72		2·9	2·8–3·0	
Head length/inter-orbital	3·22		3·0	4·0–4·12	

In addition to the above series of ratios of body proportions the following list is added. These refer to this single Queensland example :—

Body length/snout to origin of 1st dorsal fin	4·81
Body length/snout to origin of 2nd dorsal fin	1·92
Body length/snout to origin of ventral fins	4·20
Body length/snout to vent	1·91
Body length/length of upper + lower caudal lobes	3·24
Head length/snout to hinder edge of preopercle	1·11
Body height/interaxillary width	1·87

From the above series of values listed in table X, it is obvious that there is no significant departure from those given for Japanese examples of *S. niphonius*. Admittedly there is a difference in respect to the ratio of head length/eye diameter, but this value would depend largely on the manner in which the eye was measured. The height of second dorsal and anal fins are those recommended by Russell and the International Council (*loc. cit.*), but those given by Tanaka and Fowler presumably refer to the perpendicular heights from tip of fin to insertion with body flesh. They are necessarily smaller.

Interpretation of the body proportion ratios would suggest that the Queensland examples are sufficiently similar as to be conspecific with *S. niphonius* or *S. gracilis* of Chinese and Japanese seas.

(*e*) *Internal Anatomy.*—Liver tri-lobed with right lobe predominating in respect to length. The middle lobe appears to be divided into two smaller lobes. Both gall-bladder and spleen are longer and larger than in subgenera *Cybium* or *Indocybium*. As in *Indocybium semifasciatum* there are only two loops in the lower intestine. The general proportions are as illustrated in Text-fig. 2, No. 1. There is no swim-bladder as also noted by Kishinouye (1923).

(*f*) *Gill-rakers.*—In the only Queensland specimen examined the number of gill-rakers was found to be :—Upper limb of 1st arch—2 ; Lower limb of 1st arch—9. This value of 2 + 9 is slightly less than that given for Japanese specimens, namely 2 + 10, 3 + 11 and 3 + 9 or 10 but is sufficiently similar.

(*g*) *Lateral line.*—The lateral line as already described for subgenus *Sawara* is simple and not branched as reported by Kishinouye. There is a band of enlarged scales along each side of the lateral line and this admittedly sometimes gives the appearance of vestigial branching of the main canal. There is no true branching in Queensland specimens. The lateral line is wavy throughout its whole length and slopes gradually from its origin above the pectoral fin to the point where it finishes in the region of the tail. There are no deep inflections throughout its course. It is composed of about 210 scales.

(*h*) *Preopercle.*—The shape of the preopercle is sufficiently characteristic of the species as to warrant special mention. The postero-ventral margin is, like the pectoral fin, deeply excised and very noticeable as is evident from a glance at Plate VII, fig. A.

(*i*) *Vertebrae.*—I have no data for Australian specimens. Kishinouye gives the number as 22 + 28 in Japanese examples.

3. Synonymy.

Cybium niphonium Cuvier & Valenciennes, Hist. Nat. Poiss., viii, 1831, pp. 180-181 (after a Japanese painting) ; Richardson, Rept. 15th meet. Brit. Assn. Adv. Sci., 1846, p. 268 (Japanese seas) ; Bleeker, Verh. Bat. Gen. xxv, 1853, p. 14 (Japan) ; Bleeker, Verh. Bat. Gen, xxvi, 1856, p. 50 (Japan) ; Günther, B.M. Cat. Fish., ii, 1860, p. 371 ; Bleeker, Verh. Nat. Kon. Akad. Amsterdam. xviii, 1878, p. 15 (Japan) ; Günther, Rept. Challenger Voy., Shore Fishes, 1880, p. 66 (Inland Sea, Japan) ; Peters, Monatsb. Akad. Wiss., Berlin, xvi, 1881, p. 922 (Ningpoo) ; Temminck & Schlegel, Fauna Japonica, Pisces, 1884, p. 101, pl. LIII, f. 2 (Nagasaki) ; Kishinouye, Sui. Gak. Ho, i, 1915, p. 10, pl. I, f. 4 ; Kishinouye, Journ. Coll. Agric., Tokyo Univ., viii, 3, 1923, p. 421, figs. 6, 9, 32, 41 (N. China & Japan).

Cybium niphonicum (Error) Kner, Reise Novara, I, 5, 1869, p. 144.

Cybium gracile Günther, Ann. Mag. Nat. Hist., (4), xii, 1873, p. 378 (Cheefoo); Günther, Ann. Mag. Nat. Hist., (7), i, 1898, p. 260 (Newchang, N. China); Fowler, Hong Kong Nat., vii, 1, 1936, p. 73.

Scomberomorus niphonius Tanaka, Fishes Japan, ix, 1912, pp. 154-157, pl. XLII, f. 163-164, pl. XLIV, f. 173 (Tokyo); Jordan, Tanaka & Snyder, Journ. Coll. Sci., Univ. Tokyo, xxxiii, 1913, p. 121 (Japan); Jordan & Metz, Mem. Carneg. Mus., vi, 1, 1913, p. 26 (Fusan); Sowerby, Naturalist in Manchuria, iv, 1930, p. 197 (Pei tai Ho); Uda, Bull. Jap. Soc. Sci. Fish., i, 1932, pp. 124-129; Tanaka, Fishes Japan, 1936 abridged Popular ed., p. 146; Fowler, Hong Kong Nat., vii, 1, 1936, pp. 73-74, fig. 7; Tanaka, Jap. Fishes in life colours, pl. 132 (text in Japanese); Herre, 6th Pacif. Sci. Congress, Oceanogr., 1940, p. 213.

Scomberomorus gracilis Tortonese, Boll. Mus. Zool. Anat. Comp., Torino, xlvii (3), 100, 1939, pp. 321-322, pl. IX, f. 1.

Scomberomorus gracileus (Error) Chu, Biol. Bull. St. Johns Univ., i, 1931, p. 107.

Sawara niphonia Jordan & Hubbs, Mem. Carneg. Mus., x, 2, 1925, p. 214 (Kobe); Chu, Biol. Bull. St. Johns Univ., i, 1931, p. 107.

4. General Discussion on Diagnosis.—There may remain a little doubt as to whether Australian specimens belong to the same species as those from Japanese and Chinese waters. The break in the geographical distribution might suggest specific distinction, but making allowances for minor variations, the morphological differences between Australian and Japanese examples is not great. Markings, colouration, gill-raker counts, body proportions, shape of pectoral fin and preopercle indicate synonymy. It is possible that the nature of the lateral-line may prevent these two species from being conspecific. Although the lateral-line is reputed to be branched in oriental specimens, there is no evidence of such branching in examples caught in Queensland waters. This character apparently is of some importance since Jordan & Hubbs (1925) used this feature to separate their subgenus *Sawara*. At the same time it is well worth noticing that Tortonese (1939) reinstated Günther's name "*gracilis*" for application to an oriental specimen which lacked branching of the lateral-line. As stated earlier, it is very probable that the branching of the lateral-line is not as noticeable or as regular as described by Kishinouye and followed by later authors. Australian examples fit well enough the descriptions and resemble in the main essentials the illustrations of Cuvier & Valenciennes (1831), Günther (1860, 1873), Temminck & Schlegel (1884), Tanaka (1912), Kishinouye (1923), Fowler (1936) and Tortonese (1939). As already suggested in the description of the subgenus *Sawara*, there appears to be insufficient justification for considering *S. niphonius* and *S. gracilis* separate species. Also, it is reasonable to accept that the Australian form is similarly conspecific.

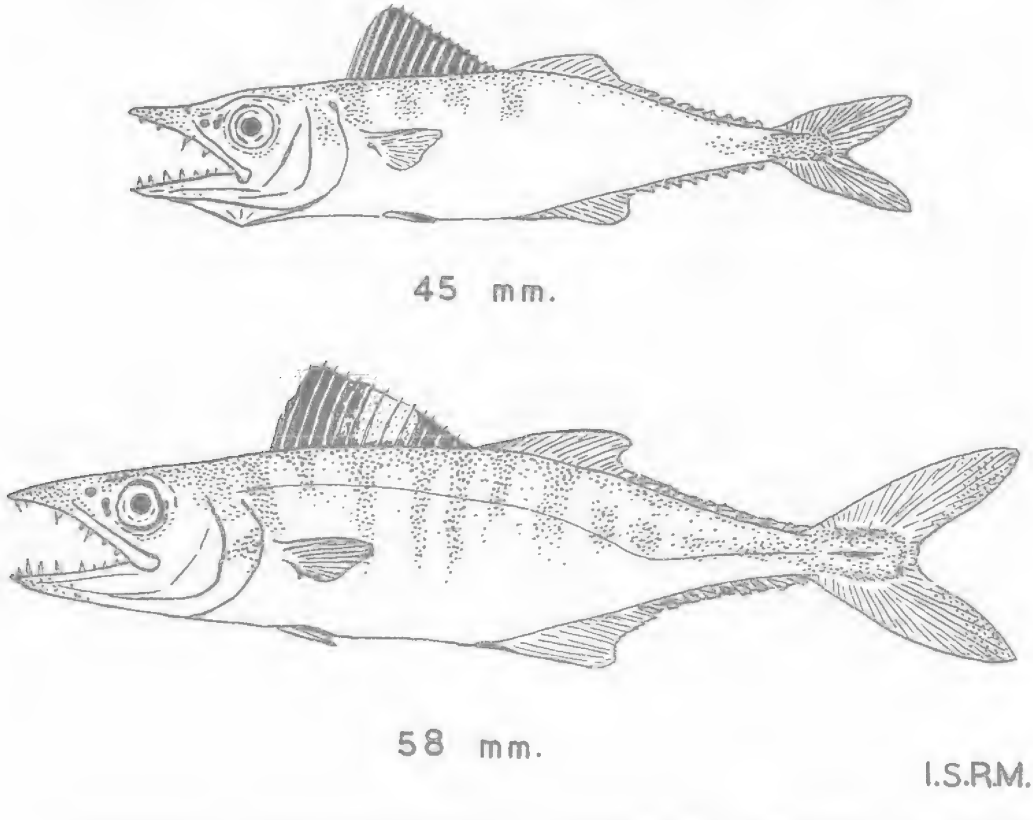
This species is readily distinguishable in the field by the long spinous dorsal fin, the excised pectoral fin and preopercle and the body covering of comparatively large scales.

It is possible that some of the records of "*C. guttatum*" in Australian fish literature may refer to this species, but more likely the majority refer either to *S. semifasciatus* or *S. queenslandicus*. There are no specimens of this species in Australian Museums.

SCOMBEROMORUS (INDOCYBIUM) SEMIFASCIATUS (Macleay) 1883.
BROAD-BARRED SPANISH MACKEREL.

Plates VI and VIII; Text-Fig. 4.

1. DISTRIBUTION.—This species is limited to Australian waters. It is not well-known. Records indicate that the distribution is limited to the tropical and semi-tropical coastal waters of Queensland and Northern Australia. No adequate data is available from Western Australia. Macleay's type specimen comes from the Burdekin River, Nth. Queensland and De Vis' holotype (*i.e. C. tigris*) from Cape York. I have seen and examined innumerable specimens from the Queensland coast from Moreton Bay in the south to Townsville in the north. There are specimens (I.5296-9, IA.7669 and IA.7670) in the Australian Museum collection to confirm that the distribution extends into the Northern Territory at least as far as Darwin. Rendahl's (1921)



Text Fig. 4.—Immature specimens of *Scomberomorus* (*Indocybium*) *semifasciatus* (Macleay), from Townsville, North Queensland. Lengths to caudal fork = 45 mm. and 58 mm. respectively. The body markings are as in adult fish.

specimen of "*C. guttatum*" = *S. semifasciatus* enables us to further extend the range westwards to Broome in N.W. Australia. A head and tail (I.6323-4) in the Queensland Museum collection indicates that the distribution also stretches northward into the Torres Straits (Thursday Is. and Coconut Is.). The distribution can be summed up as Australian coastal waters within the limitations set by the parallels of 10° S. and 30° S. latitude.

2. DESCRIPTION.—(*a*) *Size.*—Published descriptions of this species deal only with small specimens. Examples of 1000 mm. (ca. 40 inches) are not uncommonly

seen in Brisbane Fish Markets. Fish of 600 mm. to 900 mm. are caught on the fishing grounds north of Yeppoon in November while smaller age groups are caught in the estuaries along the Queensland coast north of Moreton Bay. Immature stages ranging in size from 4·5 to 10·0 cm. (*see* Text-fig. 4) are common along the beaches in the vicinity of Townsville during the month of November and grow to twice this size by January. Examples measuring 300 to 400 mm. are probably one year old.

(*b*) *Colour*.—In immature specimens (*i.e.* less than 100 mm.) the colouration in life is as follows :—Cranial regions and upper regions of the back are pale green with a bronze sheen and marked with about twelve to twenty broad vertical bands of a dark grey. These bars are confined to the region of the body above the lateral-line and their number increases with age. The cheeks and belly are silvery white. The snout is a dark slate grey and there is a patch of green above the orbit. The spinous dorsal fin is jet black with contrasting areas of white in its central region. The second or soft dorsal fin is cream with yellow anteriorly. The anal fin and all finlets are of a transparent white. The caudal flukes are creamy white at their margins and dusky or blackish near the hypural. The pectoral fins are dusky.

As the species increases in size the bronze-green colouration of the back turns to a greenish blue. The vertical bands on the back are most marked in specimens less than 500 mm. length and in larger fish there is a tendency for these markings to become less distinct, break into spots or fade out more or less completely. Above 700 mm. dead fish assume a drab greyish-yellow blotchy appearance with little or no evidence of markings. This uniform grey colour apparently accounts for the vernacular " Grey Mackerel " of Queensland fishermen as applied to older age groups of the species. The younger age groups caught in the Queensland estuaries principally Moreton Bay and Hervey Bay are called " Brownies " or even " Striped School Mackerel."

(*c*) *Fin Formulae*.—Not very much material has been available for this determination but an idea of the range of variation of the various fin counts can be gleaned from the following table (XI) :—

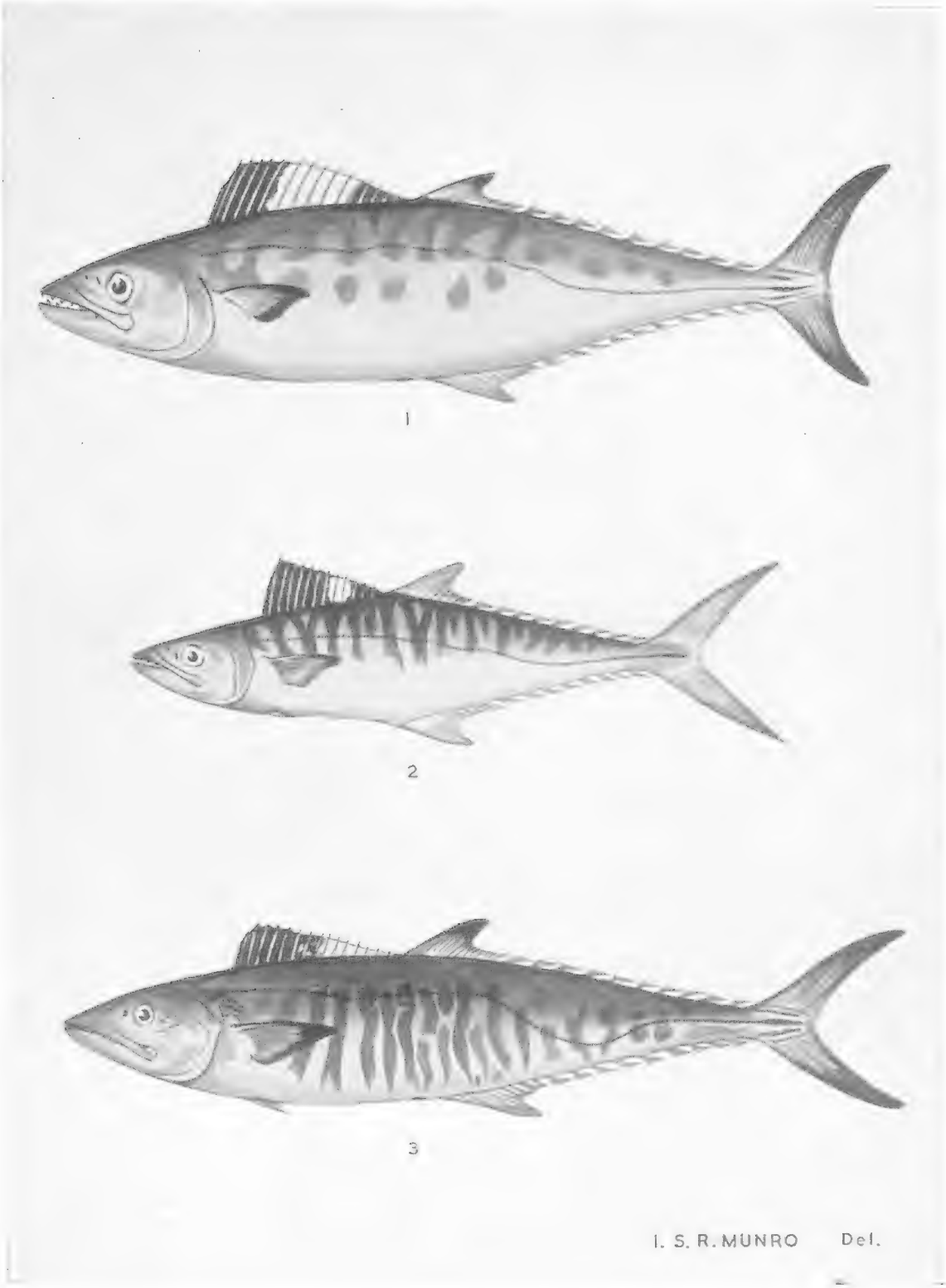
TABLE XI.—FIN COUNTS OF *S. semifasciatus*. SERIES FROM THE QUEENSLAND COAST.

No. of spines and rays.	8	9	10	13	14	15	17	18	19	20	21	22	23	Total No. of Individuals.
1st Dorsal ..				2	7	7								16
2nd Dorsal ..							1	2	13	2				18
Dorsal Finlets	2	11	3											16
Anal ..										3	13	2		18
Anal Finlets	3	10	3											16
Pectoral ..												2	10	12

The range of variation in fin counts are thus—
D, 13-15 ; 17-20 ; 8-10. A. 20-22 ; 8-10 ; P, 22-23.

The average (*i.e* modal) fin formula can be taken as—
D, 14 + 19 + 9. A, 21 + 9. P, 23.

This formula is identical with the fin count in De Vis' holotype of *Cybium tigris* as recounted by Whitley (1936).



Australian Spanish Mackerel.

Fig. 1.—*Scomberomorus* (*Cybium*) *queenslandicus* sp. nov. Immature specimen from Brisbane River, Queensland. Queensland Museum Collection Registered No. I. 7073. Length to caudal fork = 193 mm.

Fig. 2.—*Scomberomorus* (*Indocybium*) *semifasciatus* (Macleay). Juvenile specimen from Townsville district, North Queensland. Length to caudal fork = 140 mm.

Fig. 3.—*Scomberomorus* (*Cybium*) *commerson* (Lacépède), "School Mackerel." Immature specimen from Mackay district, North Queensland, 4th September, 1941. Length to caudal fork = 368 mm.

The shape of the pectoral fin calls for special comment. Unlike most other Scomberomoridae the pectoral fin is not falcate. At least in older fish the margins of the pectoral fin are rounded. The anterior or upper margin is distinctly convex and the lower or posterior margin is slightly concave or even sigmoid in outline. The shape is quite characteristic and is often useful in identifying the species.

(*d*) *Body proportions.*

TABLE XII.—BODY PROPORTIONS OF *Scomberomorus semifasciatus*. SERIES FROM QUEENSLAND COAST—TOWNSVILLE TO MORETON BAY. SIZE RANGE (L.C.F.) 168mm. TO 595mm.

Ratio.	Number of Specimens.	Observed Range.		Mean.	σ	Coefficient of Variation.
		Minimum.	Maximum.			
Head length/snout length	9	2·43	2·75	2·55	0·083	3·2%
Head length/eye diameter	9	5·72	8·18	6·98	0·530	7·7%
Head length/inter-orbital	8	2·83	3·24	2·98	0·122	4·1%
Head length/maxilla length	8	1·25	1·67	1·42	0·150	10·5%
Head length/pectoral fin length	9	1·67	1·96	1·81	0·086	4·8%
Body length/head length	9	4·43	5·09	4·95	0·220	4·5%
Body length/snout to origin of 1st dorsal fin	9	3·92	4·31	4·12	0·120	2·9%
Body length/snout to origin of 2nd dorsal fin	9	2·06	2·16	2·12	0·031	14·6%
Body length/snout to origin of ventral fins	8	3·82	4·31	4·07	0·165	4·0%
Body length/snout to vent	9	2·07	2·18	2·13	0·045	2·1%
Body height/interaxillary width	4	1·87	2·06	1·95	0·071	3·7%
Body length/body height at level of vent + height of 2nd dorsal fin + height of anal fin	6	1·90	2·03	1·95	0·045	2·3%
Body length/length of upper + length of lower caudal lobes	7	2·04	2·76	2·27	0·219	9·6%

In table XII is set out the variation in the principal body proportion ratios along with their mean value and standard deviation. It can be seen at a glance that this species is readily distinguishable from both *S. commerson* and *S. queenslandicus* by reference to body proportions only. The significant differences are :—

(1) Eye diameter relatively larger than in *S. commerson* and *S. queenslandicus*.

(2) Height of body at level of vent + height of 2nd dorsal fin + height of anal fin is relatively greater than in subgenus *Cybium*, *i.e. S. semifasciatus* has a mean value of 1·95 for this ratio as compared with 2·6 for *S. commerson* and *S. queenslandicus*. This feature is very striking and gives the body outline of *S. semifasciatus* a characteristic diamond shape.

(3) The caudal fin is wider (*i.e.* the tail is larger) in *S. semifasciatus* than in other Australian species. This ratio of body length/length of upper + length of lower caudal lobes has a mean value of 2·27 as compared with 3·09 and 3·37 in *Cybium* subgenus. The difference in size of the tail is very noticeable, so much so, that it is possible to detect examples of *S. semifasciatus* in a market consignment of *S. commerson* by reference to the tails only.

Casual observation would suggest that the ratio of body length/head length is relatively large, or in other words the head is small compared with the body length. It will be seen from reference to tables IV, VI and XII that this ratio is no greater in *S. semifasciatus* than in *S. commerson* or *S. queenslandicus*. The effect is apparently the result of an optical illusion caused by the disproportionately small body length/body height ratio.

In the field it is always possible to identify *S. semifasciatus* by—

(*a*) Its large tail ;

(*b*) Its great body depth in region of soft dorsal and anal fins, producing a diamond shaped outline ;

(*c*) What appears to be a relatively small head ;

(*d*) Possession of extraordinarily broad fleshy lateral keels on either side of the tail. Comparatively speaking these lateral keels are larger than those of any other Australian species of *Scomberomorus*.

(*e*) *Internal Anatomy.*—The arrangement and proportions of the visceral organs are as illustrated in Text-figure 2, No. 3. The liver is small, distinctly tri-lobed and of a uniform brown colour as in other species. The pyloric tubules are small and very numerous as in subgenus *Cybium* (*cf.* Nos. 4 and 5). The spleen is relatively smaller than in *Cybium* and *Sawara*. The lower intestine has two loops only (*cf.* four loops in *Cybium*). There does not appear to be an air-bladder present.

(*f*) *Gill-rakers.*—The number of gill-rakers in this species has never been stated by other authors. They were not given in the brief descriptions of the holotypes of *C. semifasciatum* Macleay or of *C. tigris* De Vis. The range of variation in this character has been found to be—Upper limb of first arch = 2 or 3, lower limb of first arch = 7 to 9 short smooth rakers. A typical gill-arch is illustrated in Text-figure 3. The most usual gill-raker count is probably = 2 + 8.

(*g*) *Lateral-line.*—The lateral-line is almost straight or at most only slightly sigmoid. It descends gently in the region below the spinous dorsal fin and then more steeply under the soft dorsal fin and first few dorsal finlets. It then follows a horizontal course to the caudal keels. There are about 175 to 190 scales along the course of the lateral-line. It is not branched.

(*h*) *Vertebrae.*—The vertebrae have been counted in only four specimens, all of which come from the eastern coast of Australia. Three of these have 19 precaudal vertebrae and 26 caudal (excluding hypural) vertebrae, with a total count of 45. One specimen, however, shows a slight variation in that there is one less caudal vertebra, *i.e.* with a count as follows :—19 + 25 = 44. The average vertebral count can be considered as being 19 + 26 = 45.

3. Synonymy.

Cybium semifasciatum Macleay, Proc. Linn. Soc. N.S.W., viii 1883, pp. 205-206 (Lower Burdekin River, Qld.) ; Macleay, Proc. Linn. Soc. N.S.W. ix, 1, 1884, p. 28 ; Whitley Mem. Qld., Mus., xi, 1, 1936 pp. 40-42 figs. 3-4 (in part).

Cybium tigris De Vis Proc. Linn. Soc. N.S.W. ix 3, 1884 p. 545 (Cape York).

Scomberomorus semifasciatus McCulloch & Whitley, Mem. Qld. Mus., viii, 2, 1925, p. 142 ; McCulloch, Aust. Mus. Mem., V, 1929, p. 264.

Scomberomorus tigris McCulloch & Whitley Mem. Qld. Mus. viii 2, 1925, p. 142 ; McCulloch Aust. Mus. Mem. v, 1929, p. 264.

Cybium commersonii Saville-Kent, Great Barrier Reef of Aust., 1893, p. 291, p. 311 (in part) and his Pl. XLVI, fig. 1.

Scomberomorus commersonii Stead, Edible Fishes N.S.W., 1908, p. 98 (in part) and his Pl. LXVI.

Cybium guttatum Rendahl, Klungl. Svenska, Akad. Handl., lxi, 9, 1921, p. 16 ; Whitley, Mem. Qld. Mus., xi, 1, 1936, pp. 39-40 (in part).

4. General Discussion on Diagnosis.—Having likewise examined and compared both Macleay's shrunken holotype of *C. semifasciatum* from Burdekin River (Aust. Mus. Regd. No. A.18288) and De Vis' holotype of *C. tigris* (Qld. Mus. Regd. No. I.119) from Cape York, I concur with Whitley (1936) in that these two are conspecific. Further they belong to the same species as here described. Although there can be no grounds for the idea that De Vis' fish is the young of *S. commerson* there is abundant evidence to indicate that *S. semifasciatus* has in the past been confused with both the commoner *S. commerson* and even *S. queenslandicus*. The illustrations of Saville-Kent (1893) and Stead (1908) represent typical examples of *S. semifasciatus* wrongly named. It might also be stated here that a number of specimens in the Australian Museum collection (I.5296, I.5297, I.5298, I.5299, I.15275, IA.7669, IA.7670) are also wrongly labelled as *S. commerson*. Their correct identity is *S. semifasciatus*. In this connection also it is apparent from examination of specimens that the examples of "*C. semifasciatum*" in the Australian Museum collection (IA.1598, IA.6573) as described by Whitley (1936) are typical examples of *S. queenslandicus*. Rendahl's example from Broome (N.W. Australia) described as "*C. guttatum*" would appear also to belong to this *S. semifasciatus*.

ACKNOWLEDGMENTS.

The greater part of the research involved in the above study was carried out in the capacity of Walter and Eliza Hall Research Fellow in Economic Biology at the University of Queensland, to the Trustees of which the author expresses appreciation. Grateful acknowledgment is extended to all who have in any way assisted in making this contribution possible. The Chief of the C.S.I.R. Division of Fisheries, Dr. H. Thompson and his staff, particularly Mr. G. L. Kesteven and Dr. D. L. Serventy have given guidance throughout this study and made available both collecting and laboratory facilities. The Directors of the Queensland Museum (Mr. H. Longman) and the Australian Museum have made available specimens for examination and given access to the valuable reference libraries of those institutions.

For assistance given and facilities afforded in the gathering of data in the field, appreciation is extended to Mr. J. W. D. Dick and Inspectors R. Blackburn and W. Hiddins of the Department of Harbours and Marine, Queensland; to the Queensland Fish Board; to Mr. J. Lihou and Inspectors R. Govan and P. Ludwig of Brisbane; to innumerable fishermen particularly J. Riley (Brisbane), A. Smith (Bundaberg) and P. Krohn (Townsville); and especially to Mr. G. Coates of Townsville who has made available much helpful material and information. Lastly, I wish to extend thanks to Mr. T. C. Marshall, Assistant Chief Inspector of Fisheries, who has done much to encourage this particular study.

TERTIARY FRESH-WATER FISHES AND CROCODILIAN REMAINS FROM GLADSTONE AND DUARINGA, QUEENSLAND.

By E. Sherbon Hills, University of Melbourne.

Plate IX.

The occurrence of fish remains at Duaringa in freshwater Tertiary deposits was reported by Dunstan in 1900. The remains were stated to consist of an " abundance of fragments, including spines, vertebrae, and scales, and a well-preserved specimen of a headless fish, which must have been about 4 inches long when perfect. In addition, there is the impression of the head of another fish and an imperfect impression of a crustacean." The presence, in the Tertiary oil-shales at The Narrows, Gladstone, of " ostracods and plant remains similar to those at Oxley," has been mentioned by Jones (1926).

A general similarity in the lithology and fossil content of many of the isolated deposits of freshwater Tertiaries in Eastern Queensland has been noted by Ball (1915), Dunstan (1900) and Jones (1926), and apparently there has been a tendency to regard the various local deposits as being approximately contemporaneous (*see* especially Jones, 1926). Bryan and Whitehouse (1926) have, however, issued a timely note of warning against this view. The flora and fauna of the Palaeogene (? Oligocene) Redbank Plains Series bear a strong general resemblance to forms now living in parts of Queensland. Many of the plant genera are represented in the existing flora ; the insects are related to living forms ; the fishes include *Epiceratodus*, an Osteoglossid and *Percalates*, and there are also Crocodilians, and a fresh-water tortoise apparently identical with the living *Chelodina insculpta*. Since so many of these forms are represented by allied species or closely related genera in the existing flora and fauna, it is clear that the general assemblages of fossils in all fresh-water Tertiary formations of appropriate facies in Queensland will bear marked family resemblances, and that it will be only on a basis of careful and detailed palaeontological studies that it will be possible to determine their relative age. It will, moreover, always be extremely difficult to effect a correlation with the standard European Tertiary succession on palaeontological grounds alone.

The material described herein comprises only a few fragmentary remains from Duaringa, the collection (referred to above) that was examined by Dunstan being no longer available. In addition, there is a larger number of specimens, obtained from bores at The Narrows, near Gladstone. Naturally, these specimens are also fragmentary, but they are excellently preserved in shale and oil-shale, and have fortunately yielded material sufficiently definite to establish with certainty the general characters of the assemblage. The collections were forwarded to me by Mr. L. C. Ball, Chief Government Geologist of Queensland, to whom I am indebted for the opportunity to examine and describe an interesting suite of fossils. Material for comparison was kindly made available to me by Mr. Heber Longman, Director of the Queensland Museum, and by Mr. G. Mack, of the National Museum, Melbourne. For the photographs (Plate IX), I am indebted to Mr. J. S. Mann.

*Faunal List.**

Locality 1 : The Narrows, Gladstone.

Bore 1, *Munduran*—

Depth 206 ft. *Lutjanus* sp.—pre-operculum [F1967].

Depth 212 ft. *Percalates* sp.—scales [F1968].

Depth 298 ft. *Scleropages* aff. *leichardti*—operculum and branchiostegal rays [F1969].

Bore 3, *Munduran*—

Depth 220 ft. Small Percoid fish, *incertae sedis*—various broken bones, spines, and scales [F1970].

Depth 239 ft. (i) *Epiceratodus* sp.—scale [F1971].

(ii) Crocodilian remains—dermal scutes; proximal phalangeal of fifth digit of right pes. [F1972 *a* to *e*].

Depth 256 ft. Percoid fish, *incertae sedis*—ceratohyal and epihyal bones [F1973].

Locality 2 Parish of Wallbury.

Small Percoid fish, *incertae sedis*—1st and 2nd anal spines, ceratohyal, palatine teeth, vertebrae, scales, and other fragmentary bones [F1974].

Systematic Descriptions.

Class PISCES; Sub-class Dipneusti; Order Sirenoidei; Family Ceratodontidae; Genus *Epiceratodus* Teller 1891.

NEOCERATODUS Castelnau, 1876 *nom. nud.*

EPICERATODUS sp. (Plate IX, Fig. 1).

The scale referred to *Epiceratodus* is preserved as an incomplete impression of the inner surface. It exhibits distinctive reticulate markings, which are casts of grooves on the original scale. The areas between the grooves exhibit a finely granular ornament. The size and markings of the specimen are sufficient to indicate its generic affinities with certainty. On scales of the living species, the granular ornamentation is finer than on the fossil, which I take to indicate a specific distinction, but naturally specific determination is not possible. Detached scales of *E. forsteri* show a marked tendency to curve after separation from the body, the inner surface becoming concave. The fossil scale exhibits a similar curvature.

Superorder *Teleostei*; Order Isospondyli; Family Osteoglossidae; Genus *Scleropages* Gunther 1864.

SCLEROPAGES AFF. LEICHARDTI Gunther.

Plate IX Fig. 2.

The operculum is the distinctive bone on which the determination of *Scleropages* is based. The operculum of *Phareodus*, the extinct Osteoglossid that occurs in the Tertiary deposits at Redbank Plains and Cooper's Plains, is ornamented with strong tuberculate ridges radiating from the articular facet, and its shape approximates to a segment of a circle. The operculum here described bears an indistinct radial ornament almost exactly comparable with that in *Scleropages*, and in its general

*Types in Geological Survey of Queensland Government.

dimensions it is indistinguishable from the operculum in that genus. It differs from *Phareodus* not only in ornamentation but also in its greater width as compared with its depth, and the resemblance to the living *Scleropages leichardti* is so marked that an affinity is definitely indicated with that species.

Order *Percomorphi ;* Family *Moronidae ;* Genus *Percalates* Ramsay and Ogilby 1887.

PERCALATES sp.

Bore 1, *Munduran*, 212 *ft.* (Pl. IX, Fig. 4). The two scales in this specimen are beautifully preserved in translucent chalcedony (?) so that even the individual species of the ctenoid area can be as clearly distinguished as in a scale from a living fish. As has been shown by Cockerell (1913), the scales of teleost genera are of diagnostic significance, but, unfortunately, little has been published on the minute details of the scales of Australian fishes. I have, however, examined the scales of a number of fresh-water and of some marine Percoid fishes, in order to afford some slight basis for the study of the scales in the present collection, and find no difficulty in establishing a very close similarity between the scales at 212 ft. in Bore No. 1, Munduran, with those of *Percalates* and in distinguishing them from the scales of all other genera I have examined. The resemblance is greater to *P. antiquus* than to *P. colonorum*, as shown by the smaller number of radii characteristic of the former species. The study of fish scales can, as presaged by Cockerell, be of the greatest value in determinative palaeontology, but the task of making an adequate survey by existing and fossil species is a formidable one, and must await more settled times.

Family *Lutjanidae ;* Genus *Lutjanus* Bloch 1790.

LUTJANUS sp.

The determination of *Lutjanus* is based entirely on the pre-opercular bone (Pl. IX, Fig. 3). The distinctive and characteristic features of the specimen are that the posterior edge is finely denticulate, the angulation and the horizontal margin possessing stronger denticles, all of which are retrorse : immediately dorsal to the angulation, there is a slight notch in the hinder margin of the bone, due to a posteriorly directed extension of the angle, which projects somewhat backwards from the line of the vertical limb. The shortness of the horizontal limb as compared with the vertical is also notable. These features are all characteristic of species of *Lutjanus*, and the posterior notch above the angulation is a characteristic of the genus. Although only a single bone is available in the fossil, I have no hesitation, after examining a large series of Percoid skulls, in referring the specimen to *Lutjanus*, a close comparison being possible with the living *L. erythropterus* Bloch, which, however, is smaller in the specimens available to me. Although normally marine, some species of *Lutjanus* enter fresh water, and the occurrence of the genus in The Narrows oil-shales is therefore not indicative of a marine origin for that portion of the succession in which the fossil occurs.

Indeterminate Percoid Fish.

Parish of Wallbury (Pl. IX, Fig. 5). The only remains available from the Duaringa District are a disintegrated skeleton of a small percoid fish, of which the most distinctive parts are the scales. These are preserved in finest detail, but only as impressions. They show some resemblance to the scales of *Percalates*, but certain points of difference are to be noted, such as the presence of coarser and more extensive

granulations on the inner surface near the growth centre, a well-marked ctenoid area, and a tendency towards a sub-rectangular outline with rounded corners, as in *Therapon*. The available data are, however, insufficient to warrant generic determination.

Class Reptilia ; Order Crocodilia.

The crocodilian remains consist of a broken proximal phalangeal of the fifth digit of the right pes, and four imperfect bony dermal scutes (Pl. IX, Figs. 6-9). The phalangeal bone is not so stout as the corresponding element in *Crocodilus porosus*, the estuarine crocodile of Northern Australia. Three fragmentary dermal scutes, and one small, nearly complete scute are associated with the phalangeal bone in a few inches of the bore-core, and there is no doubt that all the remains were derived from the one individual. None of the scutes shows a crest or angulation such as is present on the dorsal scutes of all living crocodilian species (Smith Woodward, 1886), and they must therefore either be ventral scutes or dorsal scutes of an extinct form, some of which did possess unkeeled dorsal scutes (Smith Woodward—Zittel, 1932). Among living crocodilians, ventral scutes are present in *Caiman* and *Jacare* only, according to Huxley (1860). It is therefore clear that the remains are those of a form that is now extinct in Australia, but, in the absence of the skull, generic determination is not possible.

GEOLOGICAL AGE.

1. *The Narrows, Gladstone.*—The fish-fauna from The Narrows is significantly different from that at Redbank Plains in the Ipswich district, to which a Palaeogene (? Oligocene) age was assigned (Hills, 1934). The extinct genera *Phareodus* and *Notogoneus* are absent, while in place of *Phareodus* the living genus *Scleropages* is found.

The absence of the dictinctly archaic elements of the Redbank Plains fauna clearly indicates a younger age for the strata at the Narrows, and this is supported by the affinity of the osteoglossid *Scleropages* with the living *S. leichardti* of Queensland rivers. The presence of *Lutjanus*, a common marine and fresh-water genus of Indo-Australian waters, also suggests a closer approach to the existing fauna, but *Lutjanus* has been recorded from the Lower Oligocene of Florida (Gregory, 1930) and therefore is of little real help. Nevertheless, the general character of the assemblage, with the genera *Epiceratodus*, *Scleropages*, *Percalates*, and *Lutjanus*, is modern, and implies a Neogene age.

The differences from the existing fauna reside in the occurrence of an extinct species of *Epiceratodus* ; a (probable) closer affinity of the *Percalates* species with the extinct *P. antiquus* rather than the existing *P. colonorum* ; and the presence of a Crocodilian now extinct in Australian waters, if not elsewhere. Pliocene fish-faunas are generally almost identical with those of the present day, and the presence of so many extinct species at The Narrows indicates a greater age than Pliocene, with some degree of certainty. I therefore take the view that the age of the strata is probably Miocene.

2. *Loc.* 2, *Parish of Wallbury.*—Of the fossils from this locality, it is possible to state only that they are Tertiary.

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PLATE. IX

Fig. 1.—*Epiceratodus* sp. Cast of inner surface of scale.
[F1971] × $\frac{4}{3}$

Fig. 2.—*Scleropages* aff. *leichardti*. Operculum, inner aspect.
[F1969] × $\frac{4}{3}$

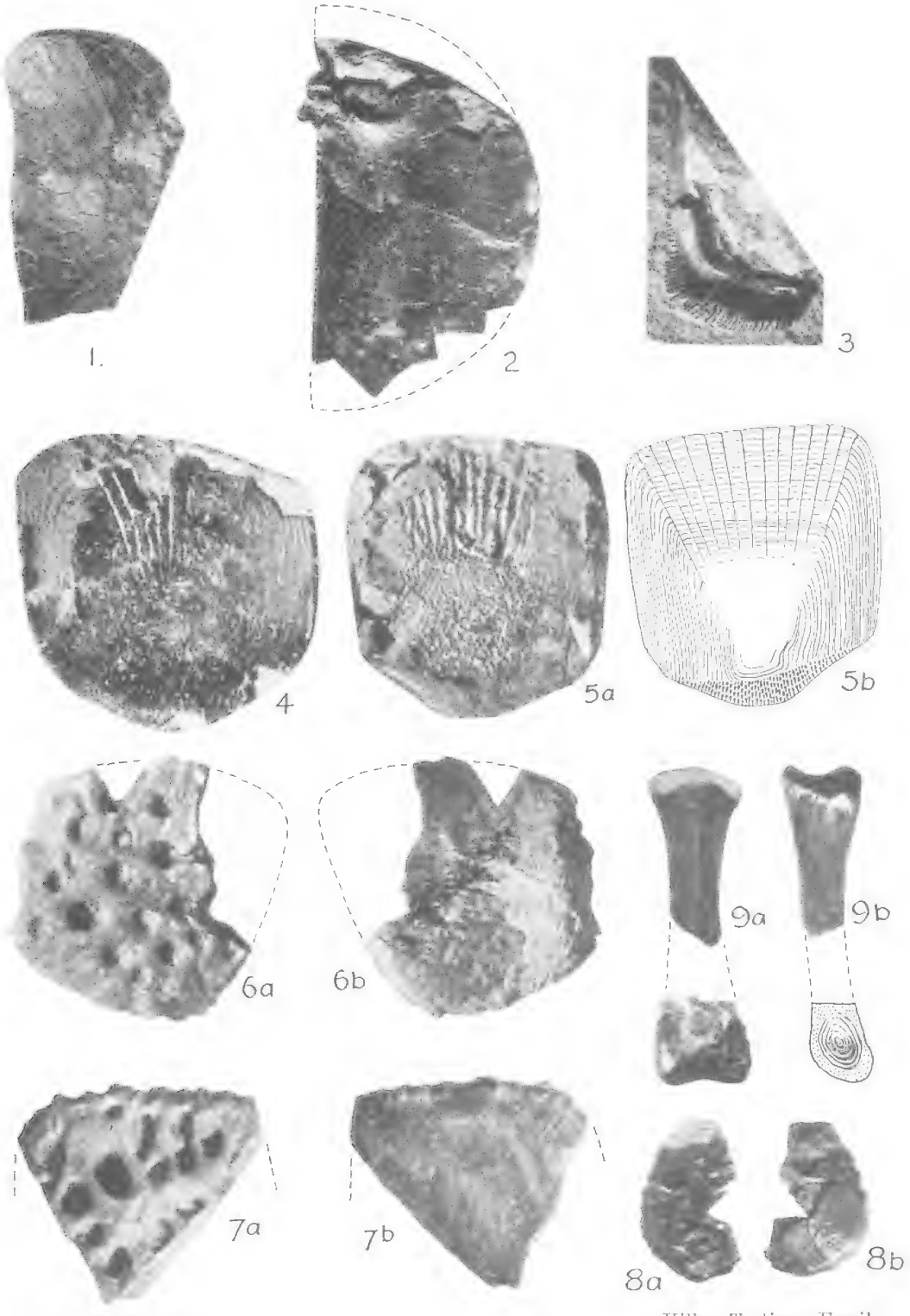
Fig. 3.—*Lutjanus* sp. Pre-operculum.
[F1967] × $\frac{4}{3}$

Fig. 4.—*Percalates* sp. Scale.
[F1968] × $\frac{2}{3}^{0}$

Fig. 5.—Percoid Fish. Scale : (*a*) cast of inner surface, (*b*) sketch of outer surface (diagrammatic).
[F1974] × 8

Fig. 6, 7, 8.—Crocodilian dermal scutes ; (*a*), (*b*), outer and inner aspects respectively.
[F1972, *a* to *c*] × $\frac{5}{3}$

Fig. 9.—Crocodilian, proximal Phalangeal, 5th digit of right pes. (*a*) Dorsal aspect ; (*b*) Lateral aspect.
[F1972, *c*] × $\frac{5}{3}$



J. S. Mann, photo.

Hills: Tertiary Fossils.

FURTHER NOTES ON AUSTRALIAN ICHTHYOSAURS.

By H. A. Longman (Director)

Plate X.

In 1922 an almost complete skull of a large Ichthyosaur from Hughenden, western Queensland, was described in detail and illustrated, with references to literature[1]. This fossil was recorded as *Ichthyosaurus australis* McCoy.

A concise description was given in 1935 of the most complete skeleton yet found in Australia, this having been collected in the same year by Mr. J. Edgar Young from Cretaceous deposits on Telemon Station, near Hughenden, western Queensland[2]. As the result of careful and persistent work by Mr. Young, this fossil has been largely cleared of matrix and it was recently placed on exhibition in the Queensland Museum, where it forms a notable addition to our palaeontological court.

The preserved portion of the skeleton is about 18 feet in length, but the posterior limbs and a section of vertebrae are missing. Over ninety vertebrae are present. The paddles are of the Latipinnate type and a pisiform articulates with the humerus, as previously recorded.

In the skull described in 1922 comment was made on the rectangular process raised above the plane of the frontal region, which suggested "apparently unique characteristics" for an Ichthyosaurian, probably requiring new generic distinction. Unfortunately this region is so much disrupted in the second skull that no evidence is available to afford satisfactory basis for a generic diagnosis. In the circumstances it is still recorded as *Ichthyosaurus australis*.

During the very laborious work of freeing the second skull (F.2453) from matrix, Mr. Young was able to expose a complete series of fifteen sclerotic plates in the left orbit, these having been buried under several inches of closely-investing calcareous mudstone.

The approximate diameter of these plates is 150 mm., whilst the diameter of the opening is 55 mm. Owing to vertical pressure the contours of the orbit are obviously flattened, but the sclerotic plates evidently occupied a very large portion of the cavity. They have been irregularly pressed inwards and two have been fractured, but the series is fairly well preserved. The apparent evidence of overlapping in this specimen is probably due to oblique post mortem pressure, which disrupted the interlocking ridges. This section is the subject of Plate X. The complete skull is approximately 52 inches (1320 mm.) in maximum length.

Fortunately another cranial fragment (F.2451), collected by Mr. Young from the same locality, showed evidence of sclerotic plates in a disrupted right orbit and these were very carefully freed from the surrounding matrix. Four contiguous plates are fairly well preserved and present no evidence of normal overlapping.

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[1] H. A. Longman, Mem. Qld. Mus., VII, pt. 4, 1922, pp. 246-256, Plates XV-XVI.

[2] H. A. Longman, Mem. Qld. Mus., X, pt. 5, 1935, p. 236.

Between two of the plates in this fragment an exposed section shows definite evidence of interlocking ridges which, in normal juxtaposition, would prevent any overlapping. The contact of the lateral edges is somewhat similar to that illustrated by C. W. Andrews (Plate 1, fig. 10) for *Ophthalmosaurus*[3].

This cranial fragment enabled a cross-section of the plates to be entirely exposed and a reconstruction, shown in Text-figure 1, was then possible. This has been used as an illustration with labels with the fossils on exhibition. A well-marked feature of the exposed plates is the thickening at the periphery, where the actual edge is convex and not rectangular. This attains a thickness of 7 mm.

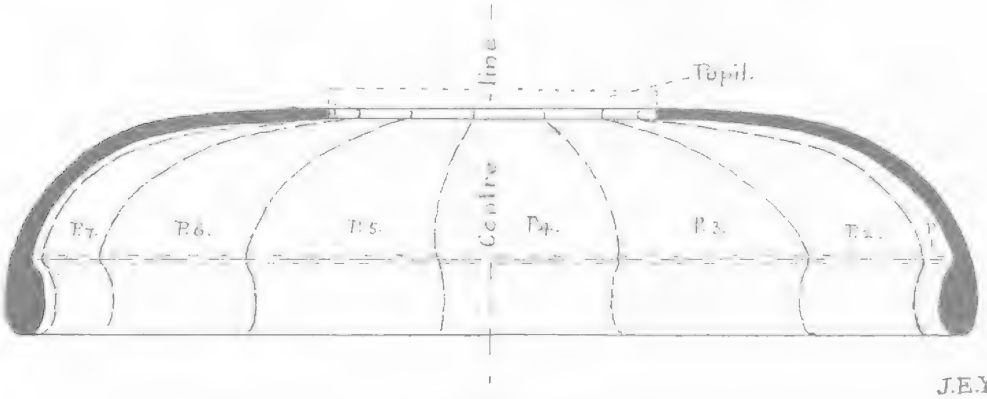

Diagram showing cross-section of Sclerotic Plates in eye of this Ichthyosaurus.

As there are very few records of the actual structure of the armoured eyes of these marine reptiles, it is hoped that the result of Mr. Young's patient work will be of some interest.

The region of the eye in McCoy's original specimen was so poorly preserved that he was only able to give a somewhat indefinite account of the sclerotic plates. He was not able to count the number of pieces precisely, but thought there were about thirteen[4].

In looking through some of the available literature regarding these well-known sclerotic plates in Ichthyosaurs, it is interesting to find diversity of opinions.

We can go back to 1814 and read Everard Home's first account of the fossil animal from Dorsetshire with the " bony sclerotic coat of the eye," to which he gave the name *Proteo-saurus* in 1819[5].

W. D. Conybeare's description of *Ichthyosaurus* in 1821[6] (using Koenig's name of 1818) also refers to the well known " sclerotica." The " bony plates of the eye " are a striking feature in the illustrations with these early accounts.

Writing of these bony plates in a Bridgewater Treatise, Dr. Buckland eloquently records " that the enormous eye of which they formed the front was an

[3] C. W. Andrews, Marine Reptiles of the Oxford Clay, Part I, 1910. Brit. Mus.

[4] F. McCoy, Trans. & Proc. Roy. Soc. Vict. IX, 1869, p. 77.

[5] Everard Home, Phil. Trans. 1814, pp. 571-576, Plate XVII, and Phil. Trans, 1819, p. 209-216, Plate XIII.

[6] W. D. Conybeare, Phil. Trans. 1821, pp. 559-590, Plate 40.

optical instrument of varied and prodigious power, enabling the *Ichthyosaurus* to descry its prey at great or little distances, in the obscurity of night, and in the depths of the sea," a statement which Richard Owen quoted in his Palaeontology.

C. W. Andrews in his great work on Marine Reptiles of the Oxford Clay (*loc. cit.* p. 31) illustrates the plates in the eye of *Ophthalmosaurus*, the edges of which interlock " in such a way that no movement can have taken place between them." He notes that the Ichthyosaurian eye " does not seem to have been satisfactorily described."

Gilmore in his elaborate study of *Baptanodon* records the overlapping of the plates, the edges of which have a long free union, allowing the sclerotic ring to expand and contract considerably[7].

Loris S. Russell in his study of " The Sclerotic Ring in the Hadrosauridae " has given an interesting account of the overlapping of these ossifications or chondrifications in a variety of vertebrates, with special reference to the Hadrosauridae[8].

Barnum Brown notes that in *Saurolophus osborni*, a crested Dinosaur from the Edmonton Cretaceous, the sclerotic plates so overlapped that " it was possible to dilate the pupil to twice its normal size." He compares this small eye in a relatively large orbital opening with the different mechanical adjustment in *Ichthyosaurus* " where the sclerotic ring fills the orbital opening. In *Ichthyosaurus* the plates are attached at their base on the outside of the ring which remains the same diameter while the plates passed over each other in dilation or contraction similar to the movement of an iris diaphragm camera shutter.[9]"

It is evident that the eyes of Ichthyosaurs present varying degrees of specialisation, perhaps the extreme being reached in the *Baptanodon* type, which were apparently the largest known among vertebrates. Doubtless some of these specialisations may be obscured by fossilisation, subsequent to post mortem contraction.

It is probable that the Ichthyosaurs, although mainly pelagic, were good divers as well as strong swimmers, and these massive plates were mainly resistant walls to varying water pressure. Even whales with their relatively small eyes may be equipped with cartilaginous protection. But we may also look for specialisations associated with the contrast of strong sunlight at the surface and the murkiness of considerable depths.

The reduction of the convexity of the actual eye-ball with a corresponding contraction of divergent plates towards the centre may be an alternative to the overlapping that has been aptly compared with the mechanism of an iris diaphragm. Muscles corresponding to the sphincter and dilator pupillae in the true iris of a modern eye, however, can scarcely be conceived as manipulating these massive plates in Ichthyosaurs, even if we suppose an extension of their functions.

The sclerotic ossifications in some species of Ichthyosaurs may have been as immobile as the rigid unsegmented ring found in certain adult birds.

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[7] C. W. Gilmore, Men . Carn. Mus. II, No. 9, 1906, p. 328.

[8] Loris S. Russell, Contrib. Roy. Ontario Mus. of Pal., No. 3, 1940.

[9] Barnum Brown, Bull. Amer. Mus. Nat. Hist., Vol. XXI, 1912, p. 136.

Among the avian eyes examined, that of the well-known nocturnal *Podargus strigoides* exhibits a homogeneous ring from which all segmentation has disappeared. The adult eye of our large sea eagle *Haliaetus leucogaster* also has a rigid unsegmented mantle of bone. These two species, one nocturnal and the other a lover of sunlight, have eyes of extraordinary efficiency.

Obviously there are many avian types with segmented rings that are largely ankylosed. At the other extreme, an imbricating series of mobile plates as recorded for some other vertebrates suggests a different function and a distinctive musculature.

Vertebrae.—In our collections there are two conjoined typical biconcave vertebrae of the Ichthyosaurian type, from an unknown locality but presumably from western Queensland, which are considerably larger than those in the skeleton now on exhibition. These were presented by the late Mr. J. Cowan, of Brisbane (Reg. No. F.1500). They have a maximum diameter of 125 mm. and a length of 56 mm. The paired tubercles are centrally situated and the vertebrae are probably median dorsals. As these are about an inch greater in diameter than those recorded by McCoy for his type specimen, which he calculated to be twenty-five feet in length, it is suggested that this species may attain at least thirty feet. These predacious reptiles, however, were dwarfed by the mighty *Kronosaurus*, which still remains the most remarkable fossil yet found from our Cretaceous deposits.

Portion of skull of *Ichthyosaurus* showing left orbit with sclerotic plates. (Approximately one-quarter natural size.)

NEW SPECIES OF LEPIDOPTERA FROM THE BARNARD COLLECTION. No. 2.

By A. Jefferis Turner, M.D., F.R.E.S.

Fam. NOTODONTIDAE.

Gen. Oxymetopa nov.

ὀξυμετωπος, with sharp forehead.

Tongue absent. Head with sharp broadly extended corneous plate projecting from its upper edge, rounded in middle, and with a short rectangular process at each corner. Palpi ascending, reaching vertex, thickened with rough scales anteriorly ; terminal joint short, smooth, slender, acute. Antennae in male shortly bipectinate to apex. Thorax not crested. Posterior tibiae with middle spurs. Forewings with areole, 2 from shortly before angle, 3 and 4 connate from angle, 6 from beyond middle of areole, 7, 8, 9 stalked from areole, 7 separating before 9, 10 separate from areole, 11 from two-thirds. Hindwings with 2 from shortly before angle, 3 and 4 connate, 5 weakly developed, 12 approximated to cell throughout. Near *Pheraspis*, differing in the frontal process and absence of thoracic crest.

Oxymetopa phaeogramma n. sp.

φαιογραμμος, darkly inscribed.

♂. 38 mm. Head and thorax dark fuscous, Palpi dark fuscous mixed with white. Antennae grey ; pectinations in male 1. Abdomen grey-whitish. Legs fuscous with whitish rings ; posterior pair mostly whitish. Forewings suboval, costa rather strongly arched, apex rounded, termen obliquely rounded ; dark grey, towards costa sprinkled with whitish ; markings dark fuscous ; a basal spot, a slightly waved outwardly curved line from one-sixth costa to one-third dorsum ; orbicular and reniform slenderly outlined, the former round, the second narrowly lunate-oval ; margin of cell and all peripheral veins slenderly outlined ; a slender line from two-thirds costa to three-fourths dorsum, incurved beneath costa and above dorsum, strongly projecting in middle ; cilia grey sprinkled with white. Hindwings white with slight fuscous irroration at apex ; cilia white, on apex fuscous.

Queensland : Talwood in April ; one specimen.

Fam. LARENTIADAE.

Gen. Probolaea nov.

προβολαιος, projecting.

Face projecting forwards in a long obtuse cone. Tongue present. Palpi slender, obliquely ascending, appressed to face as far as its apex ; terminal joint minute. Antennae in male minutely ciliated. Abdomen with a moderate crest on basal segment. Posterior tibiae of female slightly hairy on dorsum only, with two pairs of spurs ; of male shorter, slender, clothed with long hairs, and with terminal spurs only ; middle tibiae of male also short and hairy and without spurs. Forewings with areole single, and with 11 free. Hindwings with 5 curved and approximated to 4 at origin, 12 anastomosing with cell to one-fourth.

A development of *Chloroclystis* with special characters in the long facial prominence and in the legs of the male. So far as I know these are unique in this family.

PROBOLAEA ROBOGINOSA n. sp.

robiginosus, rusty.

♂. 16 mm. ♀. 22 mm. Head, thorax, and palpi pale reddish sprinkled with fuscous. Antennae grey-whitish partly annulated with fuscous. Abdomen grey-whitish sprinkled with fuscous. Legs pale ochreous-grey sometimes reddish-tinged; tarsi with dark fuscous rings. Forewings elongate-triangular, strongly dilated posteriorly, costa straight in male, slighly arched in female, apex round-pointed, termen slightly rounded, oblique; ochreous-whitish more or less suffused with reddish especially on veins and sprinkled with fuscous; markings fuscous; costa coarsely strigulated; an irregularly dentate sub-basal line; antemedian at one-fourth, slender or indistinct, indented above dorsum; followed by a blackish subcostal dot; an irregular blackish discal spot; slender or indistinct median and several post-median wavy lines; a terminal series of dots; cilia ochreous-whitish reddish-tinged with obscure fuscous bars. Hindwings with termen strongly rounded; grey; a fuscous discal dot; cilia as forewings.

Queensland: Morven in December (R. E. Barnard); three specimens.

Fam. OENOCHROMIDAE.

TAXEOTIS SPODOIDES n. sp.

σποδοειδης, like ashes.

♂. 24-27 mm. ♀. 22-25 mm. Head pale grey; face blackish. Palpi 1 and a half; blackish with sharply defined white basal area beneath. Antennae pale grey; in male slightly laminate, ciliations 1. Thorax and abdomen pale grey with slight fuscous sprinkling. Legs fuscous sprinkled with white. Forewings triangular, costa gently arched, apex sharply pointed, termen nearly straight, oblique; pale grey with slight fuscous sprinkling; markings fuscous; antemedian line straight from one-third costa to one-fourth dorsum, in female sometimes reduced to three dots or obsolete; discal dot minute, sometimes absent in female; postmedian line from two-thirds costa, slightly angled beneath costa, indistinctly double, or rather suffused, or obsolete; a subterminal line of dots more or less distinct; a terminal series of blackish dots; cilia grey-whitish with some fuscous points Hindwings with termen only slightly rounded; sometimes a minute discal dot; pale grey; terminal dots and cilia as forewings.

Queensland: Injune in October and November; seven specimens.

TAXEOTIS PLEUROSTIGMA n. sp.

πλευροστιγμος, with costal marks.

♂. 22-24 mm. Head grey; face blackish. Palpi 1; wholly blackish. Antennae grey; in male with short pectinations, each terminating in a tuft of long ciliations (2). Thorax, abdomen, and legs grey. Forewings triangular, costa slightly arched, apex obtusely pointed, termen slightly rounded, slightly oblique; grey slightly brownish-tinged with sparse irroration and markings fuscous; small costal marks at one-third and two-thirds; the former together with three dots in disc forms

an antemedian line, angled beneath costa, thence straight to one-third dorsum ; a discal dot ; postmedian and terminal series of dots starting from a subapical dot and diverging to two-thirds and five-sixths dorsum respectively ; a terminal series of dots ; cilia grey. Hindwings with termen strongly rounded ; colour, terminal dots, and cilia as forewings ; a discal dot, median, and subterminal dotted lines.

The costal marks on the forewings resemble those of *T. oraula*, but the different shape of the wing and the structure of the male antennae should prevent any confusion with this species.

New South Wales : Tooloom in March ; four specimens.

DICHROMODES LECHRIA n. sp.

λεχριος, oblique.

♂. 20-23 mm. Head, thorax, abdomen, and legs grey-whitish. Palpi 3 ; whitish-brown, lower edge towards base white. Antennae whitish-grey ; pectinations in male 6, extreme apex simple. Posterior tibiae in male not dilated. Forewings triangular, costa nearly straight, apex pointed, termen slightly rounded, oblique ; pale grey sparsely sprinkled with grey or fuscous ; a grey or fuscous median band edged by whitish lines, anterior edge obsolete towards costa, defined in dorsal half, nearly straight and oblique to two-fifths dorsum, posterior edge from five-sixths costa, slightly waved to two-thirds dorsum ; a discal dot ; a grey subterminal line edged whitish posteriorly ; an interrupted fuscous terminal line ; cilia grey-whitish. Hindwings with termen rounded pale grey ; a whitish transverse postmedian line most distinct towards dorsum ; terminal line and cilia as forewings.

Queensland : Emerald in September ; two specimens.

DICHROMODES MESOTOMA n. sp.

μεσοτομος, cut through the middle.

♀. 15-19 mm. Head, thorax, and abdomen grey-whitish. Palpi 3 ; grey-whitish. Antennae and legs grey-whitish. Forewings triangular, costa nearly straight, apex pointed, termen slightly rounded, oblique ; grey-whitish with some fuscous suffusion towards termen ; a transverse median fuscous fascia, broadest on costa, more or less constricted towards dorsum, paler towards costa, but with a subcostal discal dot, anterior edge straight, posterior edge sometimes obtusely angled ; an obscure whitish wavy subterminal line ; an interrupted fuscous terminal line ; cilia grey, apices whitish. Hindwings with termen rounded ; grey-whitish.

Cape York in June and November ; two specimens.

DICHROMODES LOXOTROPHA n. sp.

λοξοτροφος, obliquely fashioned.

♂♀. 20 mm. Head and thorax fuscous. Palpi 4 ; fuscous. Antennae fuscous ; pectinations in male 6. Abdomen grey. Legs fuscous ; posterior pair grey. Forewings triangular, costa nearly straight, apex pointed, termen nearly straight, oblique ; fuscous finely sprinkled with whitish, appearing grey ; markings dark fuscous ; a line from two-fifths costa obliquely outwards, sharply angled beneath costa, thence inwardly oblique to one-third dorsum ; a straight line from three-fourths costa to two-thirds dorsum edged posteriorly with whitish ; space between parallel portions

of these lines fuscous ; a straight broadly suffused subterminal line edged posteriorly with whitish ; an interrupted terminal line ; cilia fuscous with whitish points. Hindwings with termen rounded ; dark grey ; cilia grey.

Queensland : Carnarvon Ranges in December ; two specimens.

DICHROMODES TRITOSPILA n. sp.

τριτοσπιλος, three-spotted.

♂♀. 22-24 mm. Head, thorax, and abdomen pale grey. Palpi in male 2 and a half, in female 3 ; pale grey. Antennae pale grey ; pectinations in male 6. Legs pale grey ; posterior tibiae in male with distal two-thirds much swollen and laterally compressed. Forewings triangular, costa straight to near apex, apex pointed, termen nearly straight, oblique ; pale grey with a few fuscous scales ; small triangular blackish costal spots at three-fifths and four-fifths ; antemedian line obsolete or represented by one or two fuscous dots ; postmedian obscure, whitish with some minute fuscous dots, angled outwards above middle ; in this angle is a ferruginous spot, its outer edge bidentate and outlined with blackish ; an interrupted blackish terminal line ; cilia pale grey. Hindwings with termen rounded ; pale grey, sometimes a discal and dorsal fuscous dots, and a faint interrupted terminal line. Near *D. estigmaria* Wlk.

Victoria : Moe (C. G. Gooding) in December, February, and March ; six specimens in the Barnard Coollection.

DICHROMODES LYGROPHANES n. sp.

λυγροφανης, gloomy.

♀. 18-20 mm. Head grey ; face dark fuscous. Thorax and abdomen grey sprinkled with fuscous. Palpi 2 ; dark fuscous, lower edge except apex sharply white. Antennae fuscous. Legs fuscous ; posterior pair whitish on internal surface. Forewings triangular, costa straight to near apex, apex pointed, termen very slightly rounded, slightly oblique ; grey with slender fuscous and whitish tranverse striae, most distinct towards costa, where the former form fuscous spots ; a fuscous terminal line ; cilia whitish sprinkled with fuscous, apices paler. Hindwings with termen rounded ; dark grey with whitish striae on dorsal edge ; terminal line and cilia as forewings.

Queensland : Cunnamulla in October ; two specimens.

Fam. ARCTIADAE.

THALLARCHA POLYSTIGMA n. sp.

πολυστιγμος, many-spotted.

♂. 13 mm. Head and thorax grey-whitish. Palpi grey. Antennae fuscous ; in male bipectinate, pectinations 3. Abdomen grey ; tuft grey-whitish. Legs grey-whitish. Forewings suboval, costa rather strongly arched, termen apex rounded, termen rounded, oblique ; grey-whitish with dark fuscous dots ; a median sub-basal dot ; a dot on one-third costa, another on one-third dorsum, and a median dot between them ; a dot in end of cell ; another just beneath midcosta ; a costal dot at three-fourths, another on fold at three-fourths, and a third in disc between them ; a subcostal dot at seven-eighths, two median subterminal dots, and a fourth on tornus ; some minute terminal dots ; cilia grey-whitish. Hindwings and cilia whitish-grey.

North Queensland : Cape York in October ; one specimen.

THALLARCHA LEVIS n. sp.

levis (e short), light.

♂. 12 mm. Head whitish. Palpi grey. Antennae fuscous; in male bipectinate, pectinations 4. Thorax and abdomen grey. Legs whitish; anterior pair fuscous. Forewings suboblong, costa slightly arched, apex subrectangular, termen nearly straight, slightly oblique; whitish partly suffused with fuscous, which may form median and terminal fasciae, but these are not always present; dark fuscous dots; one median and sub-basal; one subcostal and one subdorsal at one-fifth; one median at one third; two arranged transversely in disc at two thirds; a subterminal series, more or less distinct, from four-fifths costa, outwardly curved; sometimes a terminal series; cilia grey. Hindwings and cilia grey.

North Queensland: Cape York in April, May, and June; three specimens.

Fam. NOCTUIDAE.

Subfam. AGROTINAE.

CANTHYLIDIA ATRILINEA n. sp.

atrilineus, black-lined.

♂♀. 26 mm. Head and thorax ochreous-brown. Palpi slightly over 1; whitish-ochreous, terminal joint fuscous. Antennae pale grey. Abdomen pale ochreous. Legs ochreous-whitish; anterior pair fuscous. Forewings triangular, costa straight, apex pointed, termen scarcely rounded, slightly oblique; whitish-ochreous; veins outlined blackish; cilia whitish, bases fuscous. Hindwings with termen slightly rounded, wavy; ochreous-whitish; veins outlined with blackish; a suffused fuscous terminal band; cilia whitish with fuscous dots opposite ends of veins.

North Queensland: Cape York in April and May; two specimens.

CANTHYLIDIA NERVOSA n. sp.

nervosus, sinewy.

♀. 26-28 mm. Head grey. Palpi 1; whitish, terminal joint grey. Antennae grey. Thorax grey shading into whitish posteriorly. Abdomen pale grey with some ochreous suffusion. Legs grey; posterior pair whitish. Forewings elongate-triangular, costa gently arched, apex rounded, termen rounded, oblique; whitish with some patchy grey suffusion veins outlined with fuscous; cilia whitish with fuscous bars opposite veins. Hindwings with termen rounded; slightly wavy; whitish sometimes lightly suffused with grey; cilia whitish.

Superficially similar to the preceding, but with forewings narrower, apices not pointed, and without ochreous tinge; hindwings without streaks on veins.

Queensland: Injune in April; Cunnamulla; two specimens.

CANTHYLIDIA CANA n. sp.

canus, whitish-grey.

♀. 11-12 mm. Head and thorax grey. Palpi 1; grey, white beneath. Antennae grey. Abdomen whitish-grey more or less suffused with ochreous. Legs grey; posterior pair grey-whitish. Forewings elongate-triangular, costa slightly arched, apex round-pointed, termen rounded, oblique; whitish-grey sprinkled with

fuscous especially on veins ; cilia whitish-grey. Hindwings with termen rounded ; whitish ; terminal area and sometimes also veins fuscous ; cilia whitish.

Queensland : Injune in April ; three specimens.

CANTHYLIDIA ARENOSA n. sp.

arenosus, sandy.

♀. 36 mm. Head greyish-brown. Palpi 1 ; whitish-ochreous, terminal joint fuscous. Antennae pale brown. Thorax anteriorly grey, posteriorly whitish-brown. Abdomen whitish-brown. Legs grey. Forewings elongate-triangular, costa nearly straight, apex subrectangular, termen rounded, slightly oblique ; pale brown ; a slender pale fuscous sinuate line from two-thirds costa to three-fourths dorsum ; cilia ochreous-whitish. Hindwings with termen slightly sinuate ; fuscous, paler towards base ; cilia ochreous-whitish.

Queensland : Leichhardt near Duaringa in January ; one specimen.

Subfam. ACRONYCTINAE.

EUPLEXIA C-ALBUM n. sp.

C-album, marked with a white C.

♂. 40 mm. Head and thorax dark fuscous lightly sprinkled with whitish. palpi 1 and a half ; extreme base white, basal two-thirds of second joint dark fuscous, apical third and terminal joint grey. Antennae fuscous ; in male simple. Abdomen fuscous. Legs dark fuscous with whitish rings. Forewings elongate-triangular, costa slightly arched, apex rounded, termen rounded, slightly oblique ; dark fuscous with slight patchy whitish irroration ; a blackish line from one-fourth costa to two-fifths dorsum, preceded by a whitish subcostal dot or spot ; orbicular rather large, circular, formed by a white ring incomplete posteriorly, so resembling the letter C ; reniform more obscure, its long axis transverse, ringed with whitish and this again with blackish, its anterior edge convex, posterior edge slightly concave ; a double blackish line from three-fifths costa, at first outwards, soon transverse to middle, thence incurved to slightly before tornus, slightly dentate ; a square whitish spot on costa between lines ; four white costal dots following second line ; a dorsal white dot before second line ; a dentate whitish submarginal line ; cilia dark fuscous with white bars. Hindwings with termen rounded ; grey-whitish ; a suffused grey subterminal line ; cilia whitish with a few fuscous bars.

Queensland : Bunya Mts. in November ; one specimen.

EUPLEXIA OCHRONEURA n. sp.

ὠχρονευρος, pale-veined.

♂♀. 35-40 mm. Head and thorax brown. Palpi 1 and a half ; brown. Antennae grey ; ciliations in male minute. Abdomen grey ; crests brown. Legs brown ; anterior pair with whitish tarsal rings. Forewings elongate-triangular, costa straight, apex round-pointed, termen bowed on vein 3 ; fuscous-brown ; veins and transverse lines whitish-ochreous ; a slender antemedian line from one-fourth costa slightly outwardly oblique, angled inwards towards lower extremity to end on one-fourth dorsum ; post-median from three-fifths costa, at first subcostal, then outwardly curved, finally sinuate to three-fourths dorsum ; orbicular rather large, obliquely suboval, dark fuscous partly edged with ochreous-whitish ; reniform transversely

suboblong, concave anteriorly and posteriorly; a sinuate submarginal line; an interrupted dark fuscous terminal line; cilia whitish-ochreous. Hindwings with termen rounded; ochreous-grey, darker towards termen; a pale subterminal line; cilia ochreous-whitish.

Queensland: Bunya Mts. in November; two specimens.

EUPLEXIA PHLOEOPHANES n. sp.

φλοιοφανης, resembling bark.

♀. 32 mm. Head brownish. Palpi 1 brown. Antennae fuscous. Thorax dark fuscous; patagia brownish. Abdomen fuscous lightly sprinkled with whitish. Legs whitish sprinkled with fuscous; anterior pair dark fuscous with whitish rings. Forewings elongate-triangular, costa strongly arched, apex subrectangular, termen rounded, oblique; 7, 8, 9 stalked from areole; whitish with brownish-grey and dark fuscous markings; a short oblique dark fuscous streak from base of costa; a large whitish basal spot not reaching costa, with a fuscous dot or mark in centre; a strongly curved slender dark fuscous line from one-fifth costa to two-fifths dorsum, preceded by irregular whitish suffusion; orbicular obsolete; reniform very obscure; an oval whitish dark-centred spot resting on costa beyond middle and extending nearly to mid-disc, edged anteriorly by a dark fuscous line; a slender acutely dentate dark fuscous line from two-thirds costa, incurved below middle to three-fourths dorsum, the curve filled in with grey-whitish; broad dark fuscous subdorsal marks before and after this line; some dark lines on veins in terminal area; a finely crenulate submarginal dark fuscous line crossing a whitish spot below mid-disc; a terminal line; cilia fuscous with some incomplete white bars. Hindwings with termen rounded; fuscous becoming whitish-grey near base; cilia white barred with fuscous except on dorsum.

Queensland: Stanthorpe in January; one specimen.

Gen. ANCARA Wilk.

Cat. Brit. Mus. xv. p. 1714. Hmps. Cat. Lep. Phal. vii. p. 249. Type *A. replicans* Wlk. from India.

Allied to *Euplexia*, from which it differs in the longer palpi with porrect terminal joint.

ANCARA PLAESIOSEMA n. sp.

πλαισιοσημος, marked with a square.

♂. 46 mm. Head and thorax ochreous-brown mixed with fuscous. Palpi long, second joint thickened with appressed scales, but rough anteriorly, reaching vertex, terminal joint moderately long, stout, smooth, obtuse, obliquely porrect; brown. Antennae whitish-grey; in male with long (5) fuscous pectinations extending not far short of apex. Abdomen ochreous. Legs fuscous with whitish-ochreous rings; posterior pair ochreous-whitish. Fore wings elongate-triangular, costa straight, apex round-pointed, termen rounded, oblique; pale grey slightly tinged with purple and in part suffused with ochreous-brown; basal area fuscous, bounded by a wavy pale line from one-fourth costa to two-fifths dorsum; this is immediately followed by an approximately square blackish subdorsal spot representing claviform; a pale line from four-fifths costa transversely to middle of disc, thence bent and straight, terminating abruptly above three-fourths dorsum, its end preceded by a

blackish spot ; a pale suffused median band from costa before middle reaching as far as this spot ; beyond this a large transverse oblong reniform with obscure pale outline and darker interior ; some dark fuscous terminal dots ; (cilia abraded). Hindwings with termen rounded ; fuscous with brownish-ochreous suffusion ; cilia pale grey, on dorsum ochreous.

North Queensland : Cape York in October ; one specimen.

Gen. Trilophia nov.

τριλοφιος, three-crested.

Face not projecting. Tongue strongly developed. Palpi slender, ascending, reaching about middle of face, slightly rough anteriorly. Thorax with a small bifid posterior crest. Abdomen with a large dorsal crest on basal segment and moderate crests on second and third segments. Forewings rather broadly triangular, neuration normal. Hindwings broad, cell short (about one-third), 5 straight, obsolescent, from middle of cell, 12 anastomosing with cell to about one-third.

Allied to *Euplexia*. Distinguished by the slender and only slightly roughened palpi, the small thoracic and rather large first abdominal crest, and the short cell of the hindwings, with which 12 anastomoses to about one-third.

Trilophia niphadospila n. sp.

νιφαδοσπιλος, snow-spotted.

♀. 36 mm. Head, palpi, and thorax dark fuscous, Abdomen fuscous with whitish scales on apices of segments ; crests dark fuscous. Forewings triangular, costa gently arched, apex rounded-rectangular, termen rounded, oblique ; fuscous with slight whitish irroration and obscure dark fuscous markings ; a dark spot on base of costa ; a median sub-basal dark spot ; an obscure interrupted dark transverse line at one-third ; preceding this is a fine incomplete pale ring representing orbicular ; following it a transversely oblong white ring, incomplete on its costal aspect, representing reniform ; beneath and beyond this a rather large shining white median spot ; four ochreous-whitish dots on costa between two-thirds and apex ; an obscure dark line from three-fifths costa, interrupted by a white spot, thence bent inwards and dentate to two-thirds dorsum, closely followed by a slender dark line ; a dark fuscous subterminal shade, suffused anteriorly, posteriorly well defined and dentate ; dark fuscous terminal dots edged anteriorly with ochreous-whitish ; several ochreous-whitish dots on costal half of termen ; cilia fuscous. Hindwings with termen rounded ; fuscous ; two short darker transverse lines from tornus, each edged posteriorly with ochreous-whitish.

Queensland : Rivertree near Stanthorpe in October (Mr. E. Sutton) ; one specimen.

Gen. Arboricornis Hmps.

Cat. Lep. Phal. vii. p. 358.

Tongue strong. Face not projecting. Palpi rather slender, smooth, obliquely ascending, reaching middle of face, terminal joint short. Thorax with small anterior and large posterior crest. Abdomen with dorsal crests on first four segments, that on fourth large. Forewings with a small scale-tuft on tornus ; areole absent, 7, 8, 9, 10

stalked, 7 separating after 10. Hindwings with cell one-half; 5 obsolete from middle of cell, 12 anastomosing with cell near base. This description is taken from the following species, which appears to be congeneric. In the male the antennae should be pectinate to apex, as described by Hampson from the type *A. rubra* Hmps. from India. With this he associates a second species from Africa.

ARBORICORNIS PYRRHOBAPHES n. sp.

πυρρόβαφης, reddish.

♀. 20 mm. Head, palpi, and thorax dark reddish. Antennae grey; crests dark reddish; tuft ochreous-whitish. Legs grey; posterior pair ochreous-whitish. Forewings triangular, costa moderately arched, apex round-pointed, termen slightly rounded, oblique; dark reddish; reniform obscure, represented by two grey spots placed transversely and connected by a narrow isthmus; submarginal line represented by two or three dark spots; cilia dark reddish. Hindwings with termen rounded; grey; cilia grey.

North Queensland: Cape York in June; one specimen.

SPODOPTERA ACROSPHENA n. sp.

ἀκροσφηνος, with apical wedge.

♂. 38 mm. Head brown-whitish. Palpi reaching middle of face; whitish, second joint except apex fuscous. Antennae grey; in male with fascicles of rather long ciliations (1 and a half). Thorax whitish-ochreous partly suffused with brown; patagia with fuscous and brown transverse lines. Abdomen fuscous mixed with whitish; crest brown. Legs ochreous-whitish; tarsi fuscous. Forewings narrowly triangular, costa nearly straight, apex round-pointed, termen nearly straight, slightly oblique, crenulate; whitish-ochreous with fuscous-brown markings; a series of costal dots; a broad costal streak from base to one-third, indented in middle; orbicular transversely oval, grey outlined with fuscous, and with an anterior whitish dot; reniform irregular, narrow, transversely elongate, ill-defined on costal aspect, outlined with fuscous, and separated from orbicular by a fuscous spot; a dark wedge between reniform and termen, expanded on the latter from apex to junction of middle and lower thirds, emitting a short curved process to beneath reniform; cilia ochreous-whitish with brown bars. Hindwings with termen rounded, crenulate; brownish-grey; a fuscous discal dot; cilia ochreous-whitish.

North Queensland: Kuranda in September; one specimen.

NAMANGANA ALBILINEA n. sp.

albilineus, with white lines.

♂. 36 mm. Head and palpi dark grey. (Antennae missing.) Thorax dark grey; tegulae sprinkled with whitish. Abdomen grey. Legs fuscous with whitish tarsal rings; posterior pair mostly whitish. Forewings elongate-triangular, rather narrow, costa nearly straight, apex round-pointed, termen slightly rounded, slightly oblique; grey irregularly sprinkled with whitish and with light brownish suffusion in and beneath cell and on dorsum; a whitish antemedian line, obsolete except towards dorsum, where it is represented by two sharp posterior teeth, first below middle at one-fourth, second on dorsum at two fifths; orbicular longitudinally elongate and

narrowly oval, distinctly outlined with white ; a white line on lower edge of cell ; reniform outlined with white, K-shaped, the two lower extremities connected by a more or less complete loop ; postmedian line obsolete except for an anterior tooth above dorsum ; terminal veins dark grey outlined above and beneath by white ; cilia grey with narrow white bars. Hindwings with termen rounded ; white with a narrow grey terminal line ; cilia white.

Queensland : Tweeds Hds. in September ; one specimen.

Namangana clavigera n. sp.

claviger, carrying a nail.

♂. 36 mm. Head and thorax whitish with a few fuscous scales ; face fuscous. Palpi with second joint thickened with loosely appressed scales, second joint obliquely ascending to about middle of face, terminal joint short, stout, obtuse, porrect ; whitish sprinkled with fuscous. Antennae grey ; in male shortly dentate, dentations not reaching apex, each with a tuft of cilia. Abdomen pale grey. Legs grey ; posterior pair whitish ; anterior tarsi dark fuscous with whitish rings. Forewings elongate-triangular, costa nearly straight, apex round-pointed, termen slightly rounded, slightly oblique, crenulate ; white unevenly suffused with grey and lightly sprinkled with fuscous ; markings dark fuscous ; an oblique streak, interrupted in middle from base of costa to fold ; antemedian line scarcely indicated ; closely followed by an elongate wedge-shaped spot representing claviform ; orbicular circular, partly outlined with fuscous, white with grey centre ; closely followed by an oblong fuscous spot, and this by a large white reniform, partly outlined with fuscous, and sharply indented posteriorly ; postmedian line from two-thirds costa, serrate, outwardly curved to mid-disc, thence straight to three-fourths dorsum ; an interrupted fuscous subterminal shade partly edged with white posteriorly ; a slender fuscous terminal line ; cilia whitish sprinkled with fuscous. Hindwings with termen rounded ; whitish with a pale fuscous terminal band from apex, not reaching tornus ; cilia whitish.

West Australia : Albany in February ; one specimen.

Dinoprora rufimaculis n. sp.

rufimaculis, with light red spots.

♂. 26 mm. Head brownish. Palpi 1 and a half ; white with two blackish bars on outer surface of second joint. Antennae grey ; ciliations in male minute. Thorax grey lightly sprinkled with whitish. Abdomen ochreous-whitish lightly sprinkled with grey, Legs fuscous with whitish rings posterior pair mostly whitish. Forewings elongate-triangular, costa nearly straight, apex subrectangular, termen slightly rounded, slightly oblique ; grey with whitish lines and pale red stigmata ; an interrupted oblique sub-basal line ; antemedian dentate, from one-fourth costa to two-fifths dorsum, orbicular small, circular, fuscous-edged ; reniform consisting of a narrow oblique sinuate mark, closely followed by a small oval spot with an oblique tail at its lower extremity ; postmedian from three-fifths costa to four-fifths dorsum, at first subcostal, soon bent to become transverse, below middle sinuate ; faint traces of a subterminal line ; cilia grey, apices whitish. Hindwings with termen gently rounded ; grey-whitish ; cilia whitish.

Queensland : Toowoomba in April ; one specimen.

ARIATHISA OCHROPOLIA n. sp.

ὠχροπολιος, pale grey.

♀. 40 mm. Head grey-whitish. Palpi 1 and a quarter ; whitish, outer surface of second joint dark fuscous. Antennae grey, towards base grey-whitish. Thorax grey-whitish ; bases of patagia dark fuscous. Abdomen grey-whitish. Legs grey-whitish ; anterior and middle tarsi fuscous with whitish rings. Forewings elongate-triangular, costa slightly arched, apex subrectangular, termen slightly rounded, slightly oblique ; grey-whitish ; markings and scanty irroration dark fuscous ; a series of costal dots ; a faint wavy line from one-fourth costa to one-third dorsum ; orbicular obsolete ; reniform lunate with swollen lower extremity ; postmedian represented by a sinuate series of dots ; a fuscous shade from costa before apex to dorsum before tornus, more distinct towards costa, anteriorly suffused, posteriorly sharply defined, wavy ; a submarginal series of dots ; cilia grey mixed with whitish and some fuscous dots. Hindwings with termen wavy, slightly rounded ; grey, darker towards termen ; cilia white.

Tasmania : Gravelly Beach near Launceston in February ; one specimen.

ARIATHISA GONIOGRAPHA n. sp.

γωνιογραφος, with angled marking.

♂. 28 mm. Head brownish-fuscous. Palpi fuscous, terminal joint and terminal half of second joint whitish. Antennae dark grey ; ciliations in male one-half. Thorax fuscous unevenly sprinkled with white. Abdomen grey ; tuft ochreous-whitish ; in male with lateral tufts of long ochreous-whitish hairs on basal segment. Legs fuscous with whitish rings ; (posterior pair missing). Forewings elongate-triangular, costa slightly arched, apex rectangular, termen slightly rounded, scarcely oblique ; fuscous with small scattered patches of whitish-ochreous suffusion ; a short transverse dark fuscous mark from costa near base, edged with whitish posteriorly ; an interrupted irregularly dentate blackish line from one-fourth costa to two-fifths dorsum, preceded by several small whitish spots ; orbicular a whitish dot outlined by a small blackish ring ; an interrupted irregularly dentate blackish line from midcosta to three-fifths dorsum ; reniform K-shaped, its anterior limb narrow, transverse, whitish-ochreous, edged anteriorly with blackish, posterior limb clear white, sharply angled, its upper part broader, lower part prolonged by a tail reaching postmedian line ; postmedian from three-fourths costa to two-thirds dorsum, tolerably straight, sharply dentate, followed by some whitish suffusion ; a dark fuscous subterminal band, anteriorly suffused, posteriorly separated from a narrow grey terminal band by a clear-cut edge indented beneath costa, above dorsum, and especially in middle ; some blackish terminal dots ; cilia white, bases sprinkled with fuscous. Hindwings in male with an oval scaleless tympanum with prismatic reflections just above base of cell ; termen rounded ; grey ; cilia grey, apices white except on apex of wing, dorsal cilia whitish-ochreous.

Queensland : Toowoomba in April ; one specimen.

ZALISSA STICHOGRAPTA n. sp.

στιχογραπτος, marked with streaks.

♀. 42-43 mm. Head pale brown mixed with whitish and with two longitudinal fuscous streaks. Palpi fuscous, lower edge and apices of segments brown-whitish, Antenna grey. Thorax pale brown mixed with whitish, fuscous lines on inner edges of tegulae. Abdomen pale ochreous, on crests and penultimate segment fuscous-brown with some whitish scales. Legs ochreous-whitish with fuscous bars on tarsi; anterior pair fuscous on dorsum, outer surface whitish, inner grey, tarsi fuscous. Forewings elongate-triangular, costa slightly arched, apex subrectangular, termen crenulate, bowed on vein 4; slightly excavated above tornus, on which the cilia form a small crest; brownish-grey; slight whitish suffusion beneath two-thirds costa; five fine oblique fuscous streaks from costa, the two posterior prolonged almost to termen, fine fuscous streaks on veins beyond middle with shorter intermediate streaks running to termen; an irregular whitish suffusion between angle of cell and termen below middle, its lower edge sharply defined; a dark fuscous spot beneath angle of cell; some obscure fuscous dots indicate a postmedian line, which just above dorsum is joined by a narrow lunular whitish line from three-fifths dorsum edged with dark fuscous; cilia brownish-grey. Hindwings with termen strongly rounded; basal half ochreous-yellow, terminal half dark fuscous; a narrow white band on termen beneath apex; cilia fuscous, on terminal band white, on dorsum ochreous.

Queensland: Bunya Mts. in November; two specimens.

A. H. TUCKER, Government Printer, Brisbane.

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